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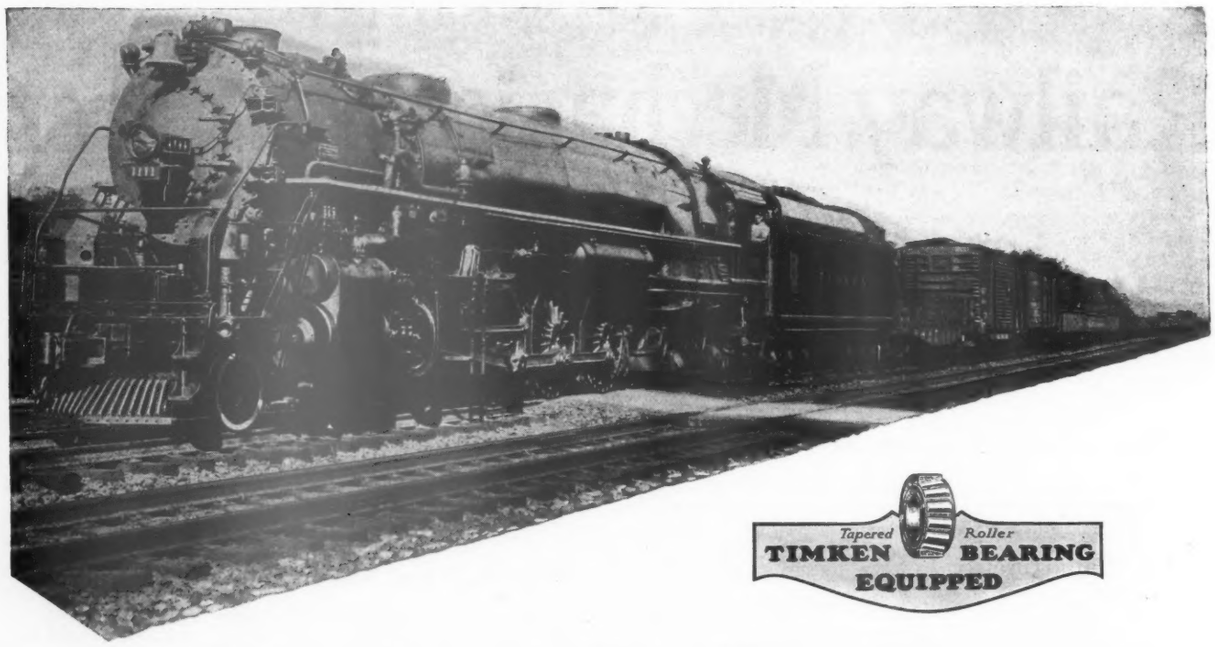

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Railway
Mechanical Engineer

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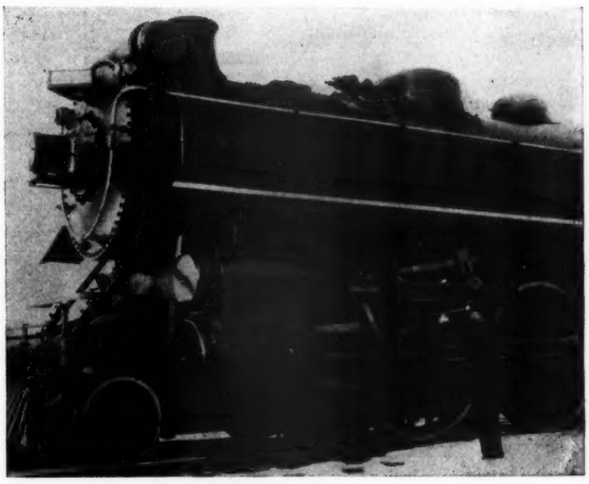
April - 1931

4-6-4 Type Locomotives on the Canadian Pacific

The Canadian Pacific has had ten 4-6-4 type locomotives in fast passenger service some of which have already made 140,000 miles—Experience with these locomotives resulted in an order for ten more of the same design — Low maintenance costs and economical performance have featured the operation of this power



Front-end view of the Canadian Pacific 4-6-4 type locomotive showing the valve-gear arrangement

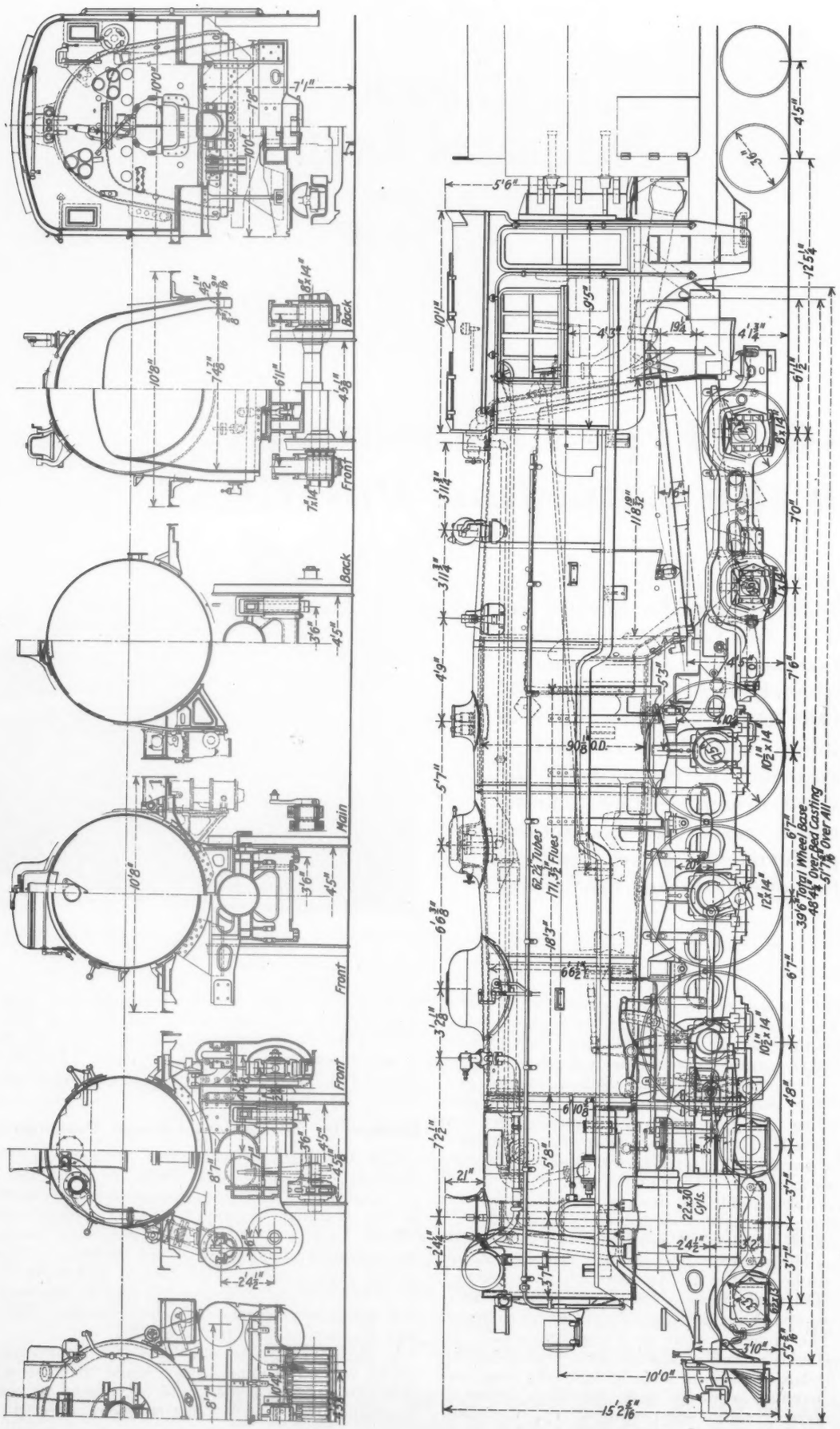
TWENTY 4-6-4 type locomotives, built by the Montreal Locomotive Works, Ltd., have been operating in fast-passenger service on the Canadian Pacific which have more than met the expectations of the designers not only with respect to maintenance and economical performance, but also from the standpoint of speed and smooth riding qualities. Ten of these locomotives, known as class Hla, have been in service since November, 1929. The second ten, class Hlb, were delivered during the last two months of 1930 and January, 1931. All 20 locomotives were built to designs furnished by the mechanical-engineering department of the railroad.

The class Hl locomotives develop a tractive force of 45,250 lb. The cylinders are of small diameter, 22 in. by 30 in. stroke and the driving wheels have a diameter of 75 in. The total weight is 350,900 lb. of which 185,000 lb. is carried as the drivers. The factor of adhesion is 4.08. The boilers operate at a pressure of 275 lb. They have an evaporative heating surface of 3,861 sq. ft. The firebox is 88⅞ in. wide by 131-1/16 long, and the grates have an area of 80.8 sq. ft. There is practically no difference with respect to important dimensions, weights and proportions between the class Hla (No. 2800 to No. 2809, inclusive) and the class Hlb (No. 2810 to No. 2819, inclusive), except for a slight increase in weight on the drivers of the latter. The Hla class carries 183,900 lb. on the drivers, as compared with 185,000 lb. for the Hlb class.

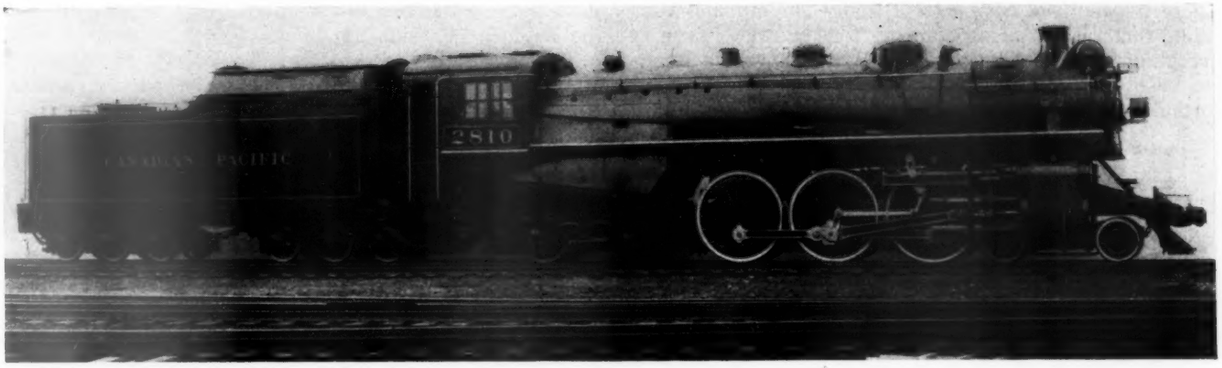
Broken In on Montreal-Chicago Passenger Runs

The locomotives were first broken in between Montreal, Que., and Smiths Falls, Ont., and then placed in extended-run through-passenger service on such trains as the "Chicago Express," "The Canadian" and the "Royal York." At the present time, these locomotives are operating on the Eastern and Western Lines on extended runs varying from 340 to 350 miles. These 4-6-4 locomotives replaced 4-6-2 type locomotives, class G-3, which were described in the December, 1923, *Railway Mechanical Engineer*, page 803.

It was not long after the 4-6-4 type locomotives were placed in service that it was found that the schedule time of passenger trains could be reduced, as was contemplated when the locomotives were ordered. These



Elevation and cross-sections of the Canadian Pacific 4-6-4 type locomotives class H1



Canadian Pacific 4-6-4 type locomotive built by the Montreal Locomotive Works, Ltd.

locomotives are capable of handling trains at extremely high maximum speeds and have demonstrated their ability to travel at average speeds of from 90 to 95 miles per hour.

A number of trial runs were made between Montreal and Smiths Falls on the Winchester subdivision, a distance of 128.7 miles. This subdivision is rolling profile with a maximum of .4 per cent grade. These runs were made with locomotive No. 2800 after it had been in service over 80,000 miles, tests being conducted without any repairs being made to the locomotive. With a 12-car train, an average of 1,021 tons behind the tender, the locomotive consumed 12,000 lb. of coal and 7,000 Imperial gal. (8,400 U. S. gal.) of water. The average coal consumption, east and westbound, was 90 lb. per 1,000 ton miles and 90 lb. per locomotive mile. The average steam pressure carried during the round trip was 258 lb. per sq. in. The average feedwater temperature was 218 deg. F. and the average superheat temperature, 625 deg. F.

With a 15-car train, averaging 1,281 tons behind the tender, east and westbound over the same division, the locomotive used 14,200 lb. of coal or 90 lb. per 1,000 ton miles and 112 lb. per locomotive mile. An average steam pressure of 266 lb. was carried; the average feedwater temperature was 214 deg. F. and the average superheat temperature, 650 deg. F. A total of 7,500 Imperial gal. (9,000 U. S. gal.) of water was used.

The same locomotive, hauling a 19-car train averaging 1,652 tons behind the tender, used 15,500 lb. of coal for the round trip, or 70 lb. per 1,000 ton miles and 118 lb. per locomotive mile, and 8,500 Imperial gal. (10,200 U. S. gal) of water. The average steam pressure carried was 274 lb.; average feedwater temperature, 222 deg. F. and average superheat temperature, 675 deg. F.

During these trial runs which began with a 12-car train of 1,021 tons, the tonnage was increased by adding one car for successive runs until the two last runs were made with 19 cars, averaging 1,652 tons. The steam pressure carried was stepped up gradually from 258 lb. with each increase in tonnage. At the same time the coal used per 1,000 ton miles gradually decreased from 90 lb. to 70 lb. The water consumption gradually increased from 6,800 Imperial gal. to 8,500 Imperial gal. The practice of varying steam pressure with train weight has proved to be economical with respect to fuel and steam consumption. It has also reduced the excessive opening of safety valves, especially on arrival at stations.

Table of Dimensions, Weights and Proportions of the Canadian Pacific 4-6-4 Type Locomotives

Railroad	Canadian Pacific
Builders	Montreal Locomotive Works, Ltd.
Type of locomotive	4-6-4
Railroad class	H-1
Service	Passenger
Cylinders, diameter and stroke	22 in. by 30 in.
Valve gear, type	Walschaert
Valves, piston type, size	14 in.
Maximum travel	7 in.
Steam lap	1⅛ in.
Exhaust clearance	¼ in.
Lead in full gear	¼ in.
Weights in working order:	
On drivers	185,000 lb.
On front truck	62,800 lb.
On trailing truck	103,000 lb.
Total engine	350,900 lb.
Tender	292,000 lb.
Total engine and tender	642,900 lb.
Wheel bases:	
Driving	13 ft. 2 in.
Total engine	39 ft. 6 in.
Total engine and tender	80 ft. 6¼ in.
Wheels diameter outside tires:	
Driving	75 in.
Front truck	33 in.
Trailing truck, front	36¼ in.
Trailing truck, rear	45 in.
Journals, diameter and length:	
Driving, main	12 in. by 14 in.
Driving, others	10½ in. by 14 in.
Front truck	6½ in. by 13 in.
Trailing truck, front	7 in. by 14 in.
Trailing truck, rear	8 in. by 14 in.
Boiler:	
Type	Conical
Steam pressure	275 lb.
Fuel, kind	Soft coal
Diameter, front ring, outside	80⅛ in.
Firebox, length and width	131⅞ in. by 88⅞ in.
Tubes, number and diameter	62—2¼ in.
Flues, number and diameter	171—3½ in.
Length over tube sheets	18 ft. 3 in.
Grate area	80.8 sq. ft.
Heating surfaces:	
Firebox and combustion chamber	313.5 sq. ft.
Arch tubes	38.5 sq. ft.
Tubes and flues	3,509 sq. ft.
Total evaporative	3,861 sq. ft.
Superheating surface	1,640 sq. ft.
Combined evaporative and superheat	5,501 sq. ft.
Tender:	
Style	Rectangular
Water capacity	12,000 Imperial gal. (14,400 U. S. gal.)
Fuel capacity	21 tons.
Wheels, diameter outside tires	36¼ in.
Maximum rated tractive force	45,250 lb.
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	52.7
Weight on drivers ÷ tractive force	4.08
Total weight engine ÷ comb. heating surface	63.7
Boiler proportions:	
Tractive force ÷ comb. heating surface	8.21
Tractive force × dia. drivers ÷ comb. heating surface	616
Firebox heat. surface ÷ grate area	4.36
Firebox heat. surface, per cent of evap. heat. surface	9.12
Superheat. surface, per cent of evap. heat. surface	42.4

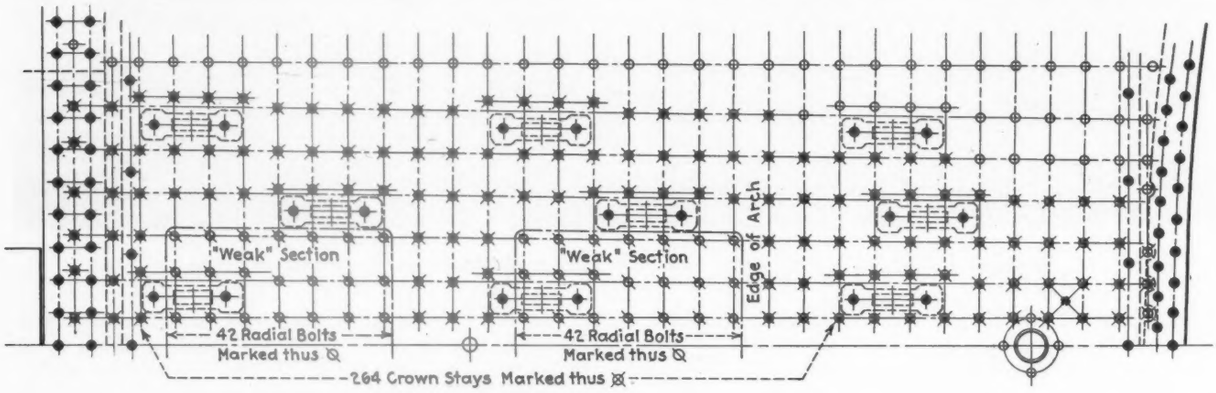
First Ten Locomotives Have Made 140,000 Miles

The first locomotives delivered have made a mileage of nearly 140,000 miles. Practically no maintenance, except the usual engine-terminal attention, has been required up to the present time. The wear on rod bushings has necessitated renewal every 50,000 to 60,000 miles. Service to date would indicate that main driving boxes require reboring after 110,000 miles service. Aside from the two items mentioned, no repairs to running gear, boiler or appliances have been required.

These locomotives were designed primarily for economical operation and maintenance and to meet the sustained speeds required in through-passenger service.

These locomotives have exceptionally smooth and easy riding qualities, insuring comfort for the crews even at maximum speeds. The cabs are of the railroad's standard vestibule type, entirely enclosed, which affords comfortable conditions in severe weather. The customary with three seats, two on the fireman's side and one on the engineman's side of the cab.

The locomotives are of conventional form, but close attention has been given to details, not only to secure efficient performance but economical maintenance. The

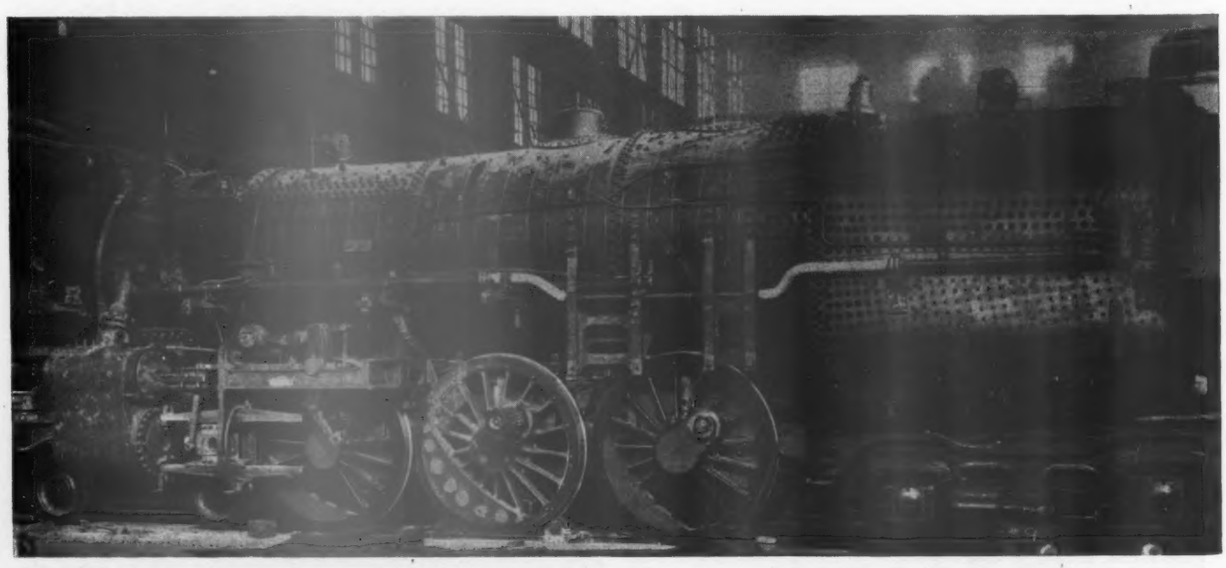


Section of crown sheet showing the "weak sections"

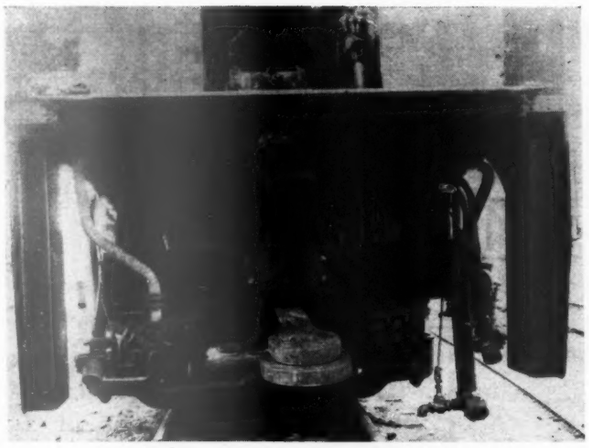
opening to the tender shoveling deck is enclosed by hinged doors, which is possible with the type BK stoker as practically no access is required to the tender coal space at any time. The cabs are illuminated at night by a single electric bulb placed in a sheet metal case attached to the roof of the cab immediately in front of the back cab wall. Two holes punched in the front side of the shade throw beams of light on the two groups of three gages located on the fireman's and engineman's side of the boiler head, respectively. The water glass is illuminated by a separate bulb contained in the cast aluminum water glass guard, the light being emitted through a saw slot directly on the tubular water glass. Additional lights, provided with socket switches, are placed on the wall of the cab directly behind the fireman's and engineman's seats for the reading of orders.

The Boiler

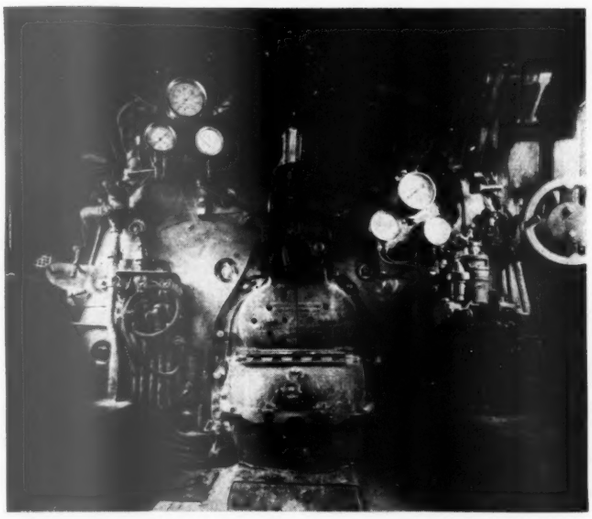
It will be observed from the illustration showing the interior view of the cab that the gages and valve handles are conveniently located for ease of access and operation. The cabs are roomy and comfortable, and are provided boiler and fireboxes are of nickel-steel construction. The crown sheet of the firebox on the last ten locomotives, owing to the strength of the nickel-steel plates, is applied with two "weak sections," which are designed to fail before any other portion of the firebox fails in case of low water in the boiler. This safety feature, illustrated in one of the drawings, tends to localize the danger should there develop a condition in the boiler which might cause a serious explosion. The "weak sections" are supported by parallel threaded staybolts and are surrounded by a zone of staybolts having tapered threads, extending from the front to the back of the crown sheet. All staybolts are of two per cent nickel-steel. The tubes and flues are electrically welded, with a special low-carbon wire (not fluxed), around the outside of the bead at the back tube sheet. This has been standard practice on the Canadian Pacific for the past nine years. The railroad has been getting an average of 130,000 miles flue service and has had little trouble with leaky flues. Tubes and flues are removed during general repairs, every 18 months to two years. No external leaks in the barrel of the boiler have been encountered



One of the Canadian Pacific 4-6-4 type locomotives under construction in the shops of the builders



Front end of tender showing the engine connections



Interior of the cab showing the back-head arrangement

thus far during the one year's operation of the first ten locomotives.

The grates are of the Rosebud or pin-hole type with an air opening of about 14 per cent. Two baffle or deflector walls have been applied underneath the mud ring, between the underside of the grates and above the ash pan, which extend the entire length of the grates. These baffles, which are not shown on the drawings, deflect the air as it enters the side of the ash pan downward and then up through the center of the grate area. In addition, the arch tubes are spaced to provide a wide arch-brick span through the center of the firebox and narrow span at the sides. The deep center arch causes the gasses to flow toward the center of the firebox and away from the side sheets.

The combination of baffle walls and arrangement of arch brick prevents the cool air from circulating along the side sheets and, because of the more uniform temperature, practically eliminating warping and cracking of the sheets and leakage of staybolts. As to be expected, with such an arrangement of baffle walls and arch brick, the fuel burns more rapidly at the center of the grates than around the sides. This is an ideal condition. The arch tubes are secured at the throat sheet and in the back head in arch-tube sleeves, which gives a rigid stayed anchorage for the tube ends and permits expansion and contraction of the arch tubes without injury to either the tubes or sheets. In addition, the firemen are instructed not to allow the fire to die down when drifting or standing so as not to subject the firebox sheets to a wide range of temperatures.

Type E superheaters are applied which provide a superheating surface of 1,640 sq. ft. Other special equipment includes an Elesco feedwater heater and a type CF boiler-feed pump.

List of Special Appliances and Equipment Applied on the Canadian Pacific 4-6-4 Type Locomotives

Railroad	Canadian Pacific
Builder	Montreal Locomotive Works, Ltd.
Service	Passenger
Boiler and Firebox:	
Blow-off cocks	Murphy
Feedwater heater	Elesco
Firebrick arch	Canada Firebrick Co. (Security)
Firebox steel	Nickel steel (C. P. R. Spec. No. 121)
Fire door	Franklin No. 8-A special
Grate shakers	C. P. R., hand-operated
Injector	Hancock
Injector check	McAvity
Jacket iron	Princess planished steel
Line checks	McAvity
Safety valves	World, Consolidated
Smokebox connection	Flextite
Staybolts, flexible	Tate or Alco
Staybolt steel	Nickel, two per cent
Stoker	Standard Type BK
Superheater	Type E
Throttle	American
Turrets, steam	McAvity
Unions (pipe)	Dart
Cylinders and Running Gear:	
Boxes—main	Grisco
Cylinder cocks	Hancock, air operated
Cylinder exhaust-passage drain	Hancock automatic
Cylinders, integral with frame	Commonwealth
Driving-box spreader castings	Franklin
Engine and tender bearings	S.K.F. (Trailing truck one loco.)
Journal bearings and brass castings	Canadian Bronze, Ltd.
Packing, (Piston rod, valve steam, air compressor, feed pump)	King
Packing, other	Garlock, Anchor, or Kearsage
Radial buffers	Franklin
Reverse gear	Screw
Truck, engine	Commonwealth
Truck trailing	Commonwealth
Tires, locomotive and tender	Peech & Tozer steel
Valve crosshead guide	Cole (Self centering)
Valves—high pressure	McAvity
Valves—low pressure	Glove (World brand)
Cab and Miscellaneous:	
Air brake, engine and tender	No. 6 Schedule E. T.
Bell ringer	Taynold, type B
Car replacers	Holco, type C
Classification lamps	C. P. R. standard
Couplings, flexible	Barco
Driving box lubricators	Franklin automatic grease
Electric headlight	Pyle National, 14 in.
Gage, cut-off control	McAvity
Headlight generator	Pyle National, type E-2
Lubricators	Nathan, B-feed
Steam gages	Star, Morrison or Crosby
Steamheat and signal gages	Star, Crosby or Morrison
Triangular number lamp	Robt. Mitchell Co.
Uncoupling device	Canadian Appliance Co., Ltd.
Water-gage glasses	Moncrieff Unific
Whistle	C. P. R. standard
Tender:	
Brake	International Equipment Co.
Draft gear	Miner A-5-X-B
Emergency light	Piper
Journal boxes	McCord
Tank hose couplings	Improved Gravity
Steamheat couplings	Gold
Underframe	Commonwealth

The steam turret from which the steam pipes lead to the air compressor, feedwater heater, blower, generator, stoker, etc., is located on the left side of the boiler immediately ahead of the cab. The operating valves lead to a bracket directly in front of the fireman's seat. The size of the piping for the steam turret to the auxiliaries has been reduced from what has been customary practice. The customary 1¼-in. steam-supply pipe to the air compressor is reduced to ¾-in. The feedwater heater pump steam supply is furnished through a $\frac{15}{16}$-in. opening. The other auxiliaries are supplied steam as follows: Through a 17-in pipe to the blower and whistle; ½-in. pipe to the turbo generator; 1¼-in. for the stoker engine and jets with a 1-in. line from the control manifold to

(Concluded on page 185)

Layouts of Locomotives On Curves*

By R. F. Hall

A presentation of the factors involved in laying out locomotives on curved track to determine if their wheel base arrangement will permit them to pass around a curve of a given radius—The errors involved in making various types of layouts are discussed by the author—Part I

LAYOUTS of locomotives on curved track are frequently required for the purpose of determining whether their wheel base arrangement will allow them to pass around a curve of a given radius, to show the relation of relatively movable parts to each other, or the relation of the locomotive to others on the same or adjacent tracks.

In making these layouts various methods are in use which employ, in a greater or less degree, certain simplifying factors, either to reduce the labor of computation or to limit the layout to a convenient size. While these approximations generally involve errors which are negligible, particularly in view of the variations in the actual construction, they may, under some conditions, lead to serious error. It is the purpose of this article to show how the extent of the error may be determined and controlled.

The simplest layout method is that in which the radius of the curve and the locomotive dimensions are all drawn to the same scale, on what is known as an equal-scale diagram. In choosing the scale used with this diagram, two conflicting requirements are met: To insure accuracy of the locomotive dimensions and of the clearances especially, a fairly large scale is desirable, while if the layout is to be kept to a convenient size, or if the curve is to be drawn directly by being struck from a center, a smaller scale is preferable. A scale of 1½ in. to the foot is commonly used and this will ordinarily make it necessary to lay out the curve by means of ordinates, as shown in Fig. 1, either

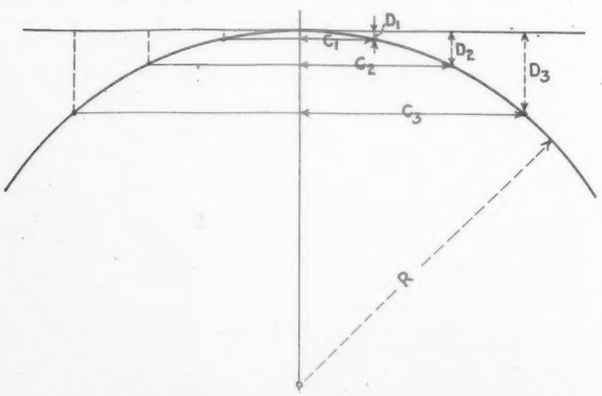


Fig. 1—Layout of a curve by means of ordinates

calculating the values of the tangent deflections D or taking them from a table such as that given on page 145 of the American Locomotive Company's handbook, in which table these values are correct within a negligible percentage of error due to the approximate formula used.

The method employing the equal-scale diagram has the advantage, as compared with those employing different scales for R, C and D, in that all parts on the layout are shown in their true relation, and the locomotive or its detail parts may be moved about in any direction relative to the rails without altering this relation. Thus, the arc described by the wheel of a pony truck rotated about the radius-bar pin center is a true arc on the equal-scale diagram, and the relation of this wheel to the rail is correct, while on a diagram having different scales for the vertical, horizontal and radius dimensions, this relation is distorted and may be very misleading.

The approximate formula for the tangent deflection D in the American Locomotive Company's tables above referred to is derived as follows:

From similar triangles, Fig. 2:

$$2R - D : C :: C : D$$

$$D = \frac{C^2}{2R - D} \quad (1)$$

$$= \frac{C^2}{R + \sqrt{R^2 - C^2}} \quad (2)$$

As D is small compared with R, this may be written:

$$D = \frac{C^2}{2R} \text{ (approx.)} \quad (3)$$

all dimensions being in the same unit. With D in inches and C and R in feet, this becomes:

$$D \text{ in.} = \frac{6C^2 \text{ ft.}}{R \text{ ft.}} \quad (4)$$

The relation between the values of D as given by the exact and by the approximate formula is:

$$\frac{D \text{ exact.}}{D \text{ approx.}} = \frac{2R}{2R - D} = \frac{2R}{R + \sqrt{R^2 - C^2}} = \frac{2R}{2R - (R - \sqrt{R^2 - C^2})} \quad (5)$$

Let $\frac{C}{R} = a$, then $C = aR$, and:

$$\frac{D \text{ exact.}}{D \text{ approx.}} = \frac{2R}{2R - R(1 - \sqrt{1 - a^2})} \quad (6)$$

and the percentage error due to the use of the approximate formula is:

$$-100\left[\frac{R(1 - \sqrt{1 - a^2})}{2R}\right] = -50(1 - \sqrt{1 - a^2}) \quad (7)$$

It will thus be seen that the approximate formula gives values of D less than those given by the exact formula, and also that the error increases and decreases with a.

* This article will appear in two parts. Part II will be published in the May issue.

Again referring to the tables given in the American Locomotive Company's handbook, the value of D when C is 40 ft. and R is 200 ft. is given as 48 in. The exact value is 48.49 in. The tabular figure is thus about 1 per cent scant, which is negligible. The maximum value of a, and consequently the maximum error, in these tables is where

$$a = \frac{40}{193} = 0.207$$

Substituting this in formula (7), the error will be found to be 1.1 per cent.

A disadvantage of the equal-scale diagram is the space which it requires. Various substitutes are used to overcome this fault and make the diagram more convenient in size. Perhaps the best known is that called the "Roy" diagram, in which, by using different but properly related scales for the dimensions, it is possible to draw the curve directly with a convenient radius, to limit the horizontal scale and thus conserve

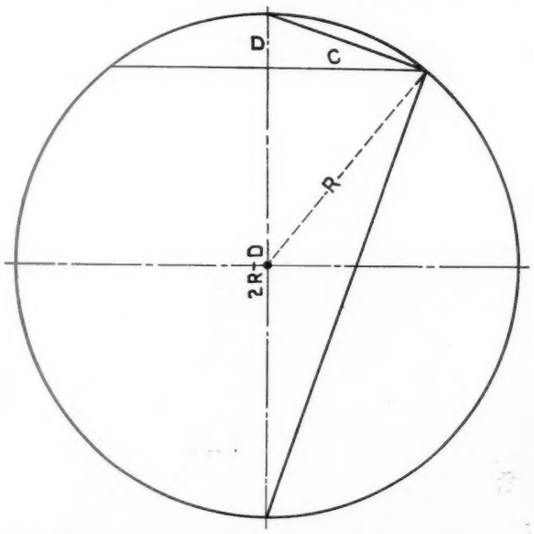


Fig. 2—Layout of similar triangles used in the derivation of the formula for determining tangent deflections

space, and to show the vertical clearance dimensions full size, or at least to a large scale. The approximate formula

$$D = \frac{C^2}{2R} \qquad (3)$$

is the basis of this method and the relation of the scales is found as follows:

Let the scale of

$$\begin{aligned} D &= 1:v \\ C &= 1:h \\ R &= 1:r \end{aligned}$$

Substituting in (3):

$$v = \frac{h^2}{r} \qquad (8)$$

$$h = \sqrt{vr}\ (= \sqrt{r} \text{ when } v = 1 \qquad (9)$$

$$r = \frac{h^2}{v}\ (= h^2 \text{ when } v = 1 \qquad (10)$$

Substituting:

$$\left(\frac{1}{v}\right) D = \left(\frac{r}{h^2}\right) D = \frac{\left(\frac{1}{h^2}\right) C^2}{2\left(\frac{1}{r}\right) R} \qquad (11)$$

Multiplying both sides by $\frac{h^2}{r}$ this becomes:

$$D = \frac{C^2}{2R}$$

which checks the accuracy of the scale relation.

It was shown above, in developing the method of determining the limits of accuracy of the approximate formula for tangent deflections, that the percentage of error is a function of $a = \frac{C}{R}$. As long as all dimensions are to the same scale, this ratio of one-half chord to radius is independent of the particular scale chosen and the error is similarly independent. However, when different scales are used, as in the Roy diagram, the error becomes a function of the layout dimensions and not of the dimensions which they represent to scale.

The accurate value of the tangent deflection was given above as

$$D = \frac{C^2}{R + \sqrt{R^2 - C^2}} \qquad (2)$$

Taking a Roy diagram, in which D is full size ($v = 1$), this becomes

$$D = \frac{\frac{C^2}{h^2}}{\frac{R}{r} + \sqrt{\frac{R^2}{r^2} - \frac{C^2}{h^2}}} \qquad (12)$$

Substituting for h^2 its value r, when $v = 1$, this is then

$$D = \frac{C^2}{R + \sqrt{R^2 - rC^2}} \qquad (13)$$

Comparing formula (13) with (2), it will be seen that C^2 in the denominator of the right-hand member becomes rC^2. If r is greater than 1, the value of the denominator is decreased and D is increased. An example follows:

$C = 15$ ft.
$R = 600$ ft.
$v = 1$
$h = 30$
$r = 900$

$\frac{C}{h} = \frac{15}{30}$ ft. $= 6$ in.

$\frac{R}{r} = \frac{600}{900}$ ft. $= 8$ in.

D, as obtained by the various formulas, is as follows:

Formula (2) 0.1875 ft. = 2.25 in.
Formula (3) 0.1875 ft. = 2.25 in.
Formula (13) 0.2260 ft. = 2.71 in.

It will be noted that the Roy diagram as represented by formula (13), shows an error of nearly ½ in., or 20 per cent, while the error in the equal-scale diagram is

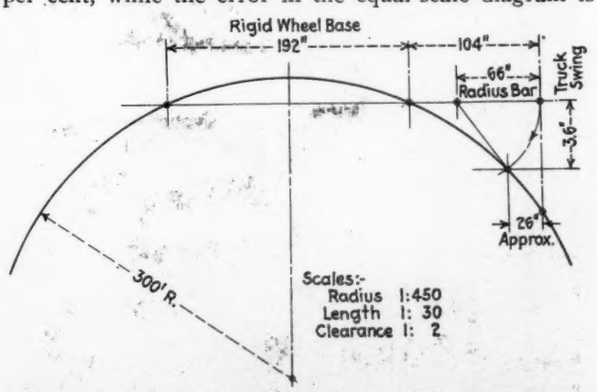


Fig. 3—A 16-ft. rigid wheel base with its wheels flanging the outer rail of a 300-ft. radius curve while the leading truck is rotated about the radius bar pin to meet the outer curved line

not apparent to the number of decimal places taken. If the scale of D is reduced and that of R correspondingly increased, the error is reduced and formula (13) becomes

$$D = \frac{C^2}{R + \sqrt{R^2 - \left(\frac{r}{v}\right) C^2}} \qquad (14)$$

(Concluded on page 177)

Radiography Applied To Railway Materials

By Herbert R. Isenburger*

A description of the equipment and methods used for the X-ray examination of castings and plate used in the construction of railway equipment

NONDESTRUCTIVE routine testing of critical structures has become of foremost importance. One of the most reliable methods is the radiographic examination. Thereby, shadow-pictures are obtained of the interior conditions of the object under investigation without destroying or in any way harming it. The means by which these pictures are made is a penetrating radiation of either X-rays or gamma-rays. The first kind of radiation is produced by electrical current through an X-ray tube; the latter rays which are of shorter wave length than X-rays are obtained from radium or its emanation.

A diagram of the radiographic arrangement is shown in one of the drawings. The focal spot *A* which is either the target of an X-ray tube or the bulb containing the radium, should be as small as possible in order to obtain sufficiently fine detail in the film *F*. When using X-radiation a heavy lead shielding *L* around the film holder *H* is essential in order to protect the negative from being fogged by secondary or scattered rays.

As with ordinary photographs, darker regions on the

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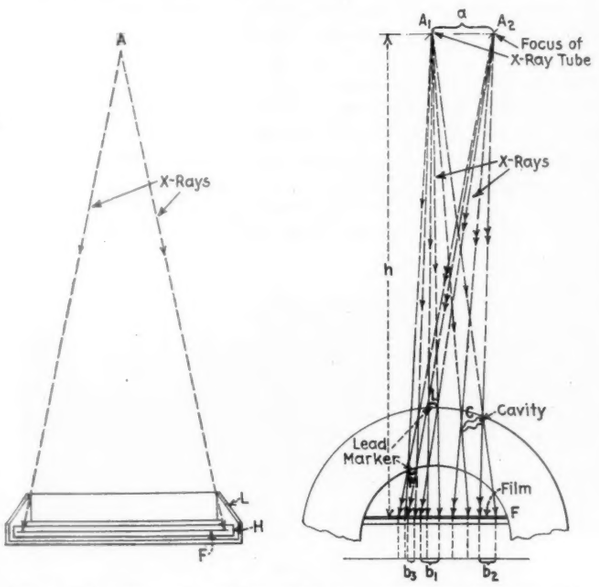
Industrial installation of portable X-ray equipment

negative or lighter regions on the print mean that more rays have passed through the object at that point which indicates that the object is more transparent there. Hence cavities will show up in the prints as light spots whereas heavy impurities or more dense metal will appear darker.

The absorption of the rays grows with the atomic weight of the material examined. It is almost propor-



Left: Diagram of radiographic arrangement—Right: Diagram showing location of sand pocket revealed in photograph shown below

tional to the third power of the atomic numbers and weights, which are shown in the following table:

Element	Atomic Number	Atomic Weight
N	7	14.00
O	8	16.00
Mg	12	24.32
Al	13	26.97
Fe	26	55.84
Cu	29	63.57
Zn	30	65.38
Mo	42	96.00
Sn	50	118.70
W	74	184.00
Pb	82	207.20

On account of its heavy atomic weight, lead is used to protect the operator, since sufficient thicknesses of lead will absorb the rays completely.

Railroad Applications of X-Ray Inspection

There are two particular fields in the railway industry where radiographic inspection is of utmost value: foundry and welding practice. In foundry practice there are two important applications of metal radiography. One of these concerns the development of manufacturing technique, the other the final inspection of the finished product. Although this method seems expensive, there are many cases where the possible failure of a casting or forging would cause damage far in excess of the cost of the examination. Here radiographic inspection becomes a matter of insurance.

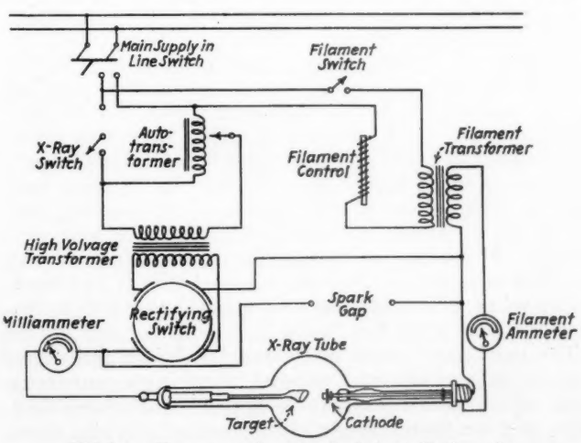
X-ray tests confirmed by cutting a section of the casting and by other means of examination indicate that the undesirable internal conditions in castings fall into relatively few classes, all of which are traceable to definite and simple causes. Most of these causes, if not all of them, can be eliminated by proper foundry practice. Experience shows that when defects have been corrected by making the required changes in foun-

Large sand pocket in 2½-in. cast steel

dry methods, they tend to stay corrected. It is thus possible, by the aid of radiography and the conclusions drawn from its results, to eliminate from 75 to 90 per cent of the more important defects in castings produced by a given foundry.

Conditions Found in Steel Castings

The principal undesirable conditions in steel castings revealed by radiographic examination are the following:



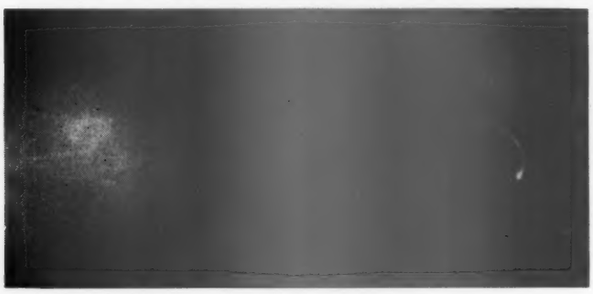
Wiring diagram of a typical installation for generating X-rays

1—Gas, slag and sand pockets due to loose dirt in the mold.

2—Gas cavities due to imperfectly deoxidized metal.

3—Sand inclusions due to cutting of the mold or runners. An illustration depicts a large sand pocket in a section of cast steel 2½ in. thick. In order to determine the depth and location inside the wall two exposures have been made on the same film as schemati-

cally shown in one of the drawings. Lead markers L and M were placed on the outer and inner surface of the castings. Before taking the second picture the source of radiation A was moved in any one rectilinear direction at a predetermined distance $A_1A_2 = a$. The distance h between focus and film was also predetermined. The film then records two images of the same cavity C and markers, L and M. The respective displacements can be measured on the film; they may be b_1, b_2 and b_3 inches. Referring to the photograph, the shadows of the reference marks on the outer surface were displaced $\frac{9}{16}$ in. or more; and the small marker on the inner surface $\frac{3}{8}$ in. In the same way displacements of various spots in the sand pocket have been measured. It was thus determined that the inclusion lies just under the outer surface and does not penetrate more than one quarter through the wall; hence it does not cause any serious defect, and an expensive



Portion of steel casting passed by the customer's inspector as being particularly good

casting which would have been rejected was saved. This particular casting weighed over three tons.

4—Pipe or primary shrinkage caused by failure of the risers to function as indicated.

5—Secondary pipes caused by flow of viscous metal through constricted channels in the casting during the final stages of solidification.

6—Shrinkage cracks starting from a sinus-like cavity developed during cooling.

7—Rupture developed during pressure test. One of the photographs shows a portion of a steel casting which was selected by the customer's inspector as particularly good, after applying ordinary inspection tests. The radiograph revealed a sharply defined crack starting from a small cavity or inclusion. Its location was marked with crayon on the outside of the casting, and it was found where indicated when the piece was sectioned. Moreover, micrographic examination of the material adjacent to the crack showed that it had been cold-worked. The casting was probably ruined in the very test that proved it "good."

The marked progress in locomotive design and other lines of railway activities present increasingly numerous cases where such tests may be applied and where they often will be found absolutely necessary. While these conditions are perhaps more prevalent in the case of castings, they also occur with forgings as well as bar or plate stock.

X-rays should be employed whenever advisable on steel castings and forgings having a thickness of 3 in. and less, whereas gamma-rays should be used for the examination of heavier material; 12 in. of steel have been successfully penetrated thus far. For radiographic inspection of welded seams, X-rays should be used whenever possible, since this kind of radiation gives more detail in the picture than gamma-rays. The appearance of the various defects is almost the same whether in castings or welded seams, but the precision in X-ray examination can be raised up to one per cent in 1 in. stock and less, or up to two per cent in 3-in. stock and less; but to not better than 5 per cent in gamma-ray examination; this holds good for blow holes which lie in the direction of the rays.

The location of a defect within the weld metal can be determined in a manner similar to that described, or can be calculated from the following proportion:

$$a : b = (h - x) : x$$

wherein x is the unknown distance between the defect and the film; the film being placed close to the object. In many cases this way is preferable in weld inspection where the defect is mostly a very small spot; b is the displacement of this defect.

A radiograph is shown depicting a weld in $1\frac{1}{8}$-in. stock. In this radiograph three differently dense regions

Radiograph showing weld in $1\frac{1}{8}$-in. stock

appear: Region A represents the plate, region B the built-up metal on the surface toward the X-ray tube, and region C which contains the actual weld and shows the built-up metal on the side facing the film. Although this is a porous weld it may be considered permissible for the service intended. Here lies the danger of radiographic tests of welded seams: that the picture may show an apparently bad condition which actually is permissible. In this respect X-ray inspection tends to be

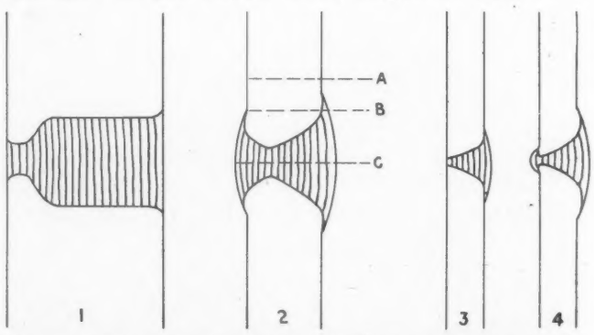


Fig. 1: Sketch showing radiograph of a sound weld in 2-in. plate stock—Fig. 2: Sketch of weld from radiograph shown above—Fig. 3: Weld shown in illustration of test plates from $\frac{5}{8}$-in. stock—Fig. 4: Sketch of a good gas weld

a rigid test, calling for skill in the interpretation of the film combined with thorough knowledge of the material's ultimate use. Its results have to be studied carefully and whenever possible, expert advice should be obtained. For certain purposes, of course, welds, as shown in the picture of the 2-in. plate stock are preferable. That they can be made and are being produced frequently has been proved by the X-ray.

Two of the X-ray pictures show electric arc-welded test plates from $\frac{5}{8}$-in. stock made by the same welder.

The top view as originally submitted for X-ray examination; and the lower view made after a thorough study of the X-ray evidence which revealed that the soundness of a weld depends not only on the answers to the preceding questions, but also on the quality of the rod and its coating, the way the welder holds the arc and the speed by which the joints are being fused together.

All welds illustrated thus far were made with the electric arc. It is equally important to inspect gas welds. Another radiograph depicts an acetylene weld which is rather good. Notice the built-up metal over the bottom of the V in contrast to the two X-ray pictures referred to in the preceding paragraph which represents the type of weld used for joining small size tubings which cannot be welded from the inside.

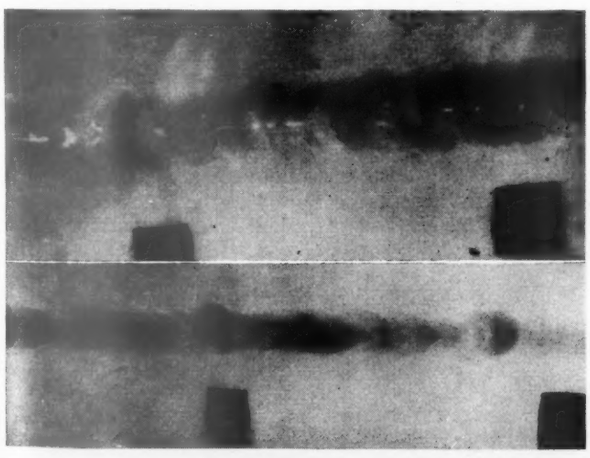
The following questions concerning welding can be answered with X-ray pictures:

Is a weld sound throughout?
Are there any inclusions of gases, slags, sand or other impurities?
Was there any undesired absorption of gas?
Is the welding rod of the proper size and was the current density appropriate?
Is a weld burned?
How did the fusion turn out (thorough penetration)?
Did any cracks develop within the welded section or the neighboring region and what causes such shrinkage?
Are there any thinner spots within the weld metal caused by improper welding procedure?
Were there any repairs made afterwards, like caulking copper welds?

In this way, not only can the welding process be improved, but work can be controlled and bettered.

Comparatively little radiographic work has been done in the railway industry in this country whereas the German State Railways uses it to considerable advantage. The management has an elaborate X-ray laboratory in its machine shops at Wittenberge near Berlin and also equipment mounted on cars with living quarters for the operator that can be sent any place where it is desired to inspect material.

The cost of suitable X-ray installations and their operating expense depend a great deal on the materials



Electric arc-welded plates from ⅝-in. stock—See Fig. 3

to be examined. The figures given below can therefore only be approximate estimates for average performances and requirements. The type of installation to be used for various inspection work depends largely upon the nature of the material, its thickness, conditions and mobility. A conservative estimate of operating cost is $3.00 to $5.00 per hour, depending on the way the equipment is written off. The cost of radiographic inspection by means of gamma-rays is difficult to estimate. The radio-active material can be rented for a certain time and in most cases the expense for such work equals the cost when X-rays are used. There are certain cases where it is easier to bring the radium to the job than X-ray equipment although the thickness of the material may be within the X-ray limits. X-rays should, however, be employed whenever possible, since they bring out better contrast and more details in a much shorter exposure time.

X-ray equipment, however, should not be installed until the adaptability of the method to the problems in hand has been demonstrated, and not then unless the benefits to be derived justify the investment. This would seem to make the tool unavailable to the organization with a small problem or a temporary difficulty.

Layouts of Locomotives On Curves

(Continued from page 173)

Thus, if we use

$$\begin{aligned} v &= 2 \\ h &= 30 \\ r &= 450 \end{aligned}$$

in the above example, the error is reduced to 4 per cent.

Even with the scale of D reduced, there may still be considerable error under some conditions. Taking a scale relation which has been used in laying out electric locomotives on curves,

$$\begin{aligned} v &= 8 \\ h &= 80 \\ r &= 800 \end{aligned}$$

Let $C = 20$ ft. $\qquad \frac{C}{h} = \frac{20}{80}$ ft. $= 3$ in.

$R = 359$ ft. (16-deg. curve) $\qquad \frac{R}{r} = \frac{359}{800}$ ft. $= 0.449$ ft. $= 5.39$ in.

D is as follows:

Formula (2) 0.558 ft. = 6.70 in.
Formula (3) 0.557 ft. = 6.68 in.
Formula (14) 0.609 ft. = 7.31 in.

The error in this case is nearly ⅝ in., or 9 per cent.

It will be understood that wherever a percentage of error is given above, it corresponds to a particular value of C and increases or decreases with C.

Another, and usually more serious, source of error in the use of this diagram has already been noted; that is, the distortion of circular arcs due to the difference in scales. Fig 3 will make this clear.

Here the scale ratios are:

$$\begin{aligned} v &= 2 \\ h &= 30 \\ r &= 450 \end{aligned}$$

and a 16-ft. rigid wheel base is shown with its extreme wheels flanging the outer rail of a 300-ft. radius curve, while the leading truck center is rotated about the radius bar pin to meet the outer curved line. The point of intersection of the arcs is nearly 26 in. to the left of its true position, but this is partly balanced by the error in the curved line, resulting as follows:

Truck lateral displacement, exact	4.27 in.
Truck lateral displacement, by diagram	3.60 in.
Error	0.67 in. (16 per cent)

The scales chosen for the above example may, of course, be modified so as to minimize the error, but it may be laid down as a general rule that the more compact the diagram, the greater the liability of error.

[In the continuation of this article unequal-scale diagrams other than the Roy will be discussed, which give more accurate and reliable results.—EDITOR]

Handling Coach Repairs On the Florida East Coast

Complete facilities for making heavy repairs and painting passenger equipment are installed at the Miller shops, St. Augustine, Fla.—Wheel shop handles repairs for the system

THE principal car and locomotive repair shops of the Florida East Coast are located at St. Augustine, Fla. These shops, which are known as the Miller shops, were built in 1925 and 1926 as part of a general improvement program that was inaugurated at that time. The Florida East Coast owns and operates 170 passenger-train cars and a considerable number of miscellaneous business and work cars which are maintained at the Miller coach shops. A high standard of maintenance is required, especially during the winter tourist season when passenger traffic is heavy. The railroad operates a considerable number of through-passenger trains, such as; the "Havana Special," the "Royal Poinciana," the "Florida Special" and "The Miamian."

St. Augustine is located 37 miles from Jacksonville, Fla., the northern terminus of the Florida East Coast. The larger part of the southbound through-passenger train service originates from connecting lines at Jacksonville. The close proximity of St. Augustine to the northern terminus of the railroad places the Miller shops in a strategic location from the standpoint of coach repairs.

Architecture of Shop Buildings Follow Spanish Style

As shown in several of the illustrations all of the buildings comprising the Miller shops follow the Spanish style of architecture. The style harmonizes with the scenery and traditions of the surrounding country and is well adapted to the climate. Palm trees set around the shop buildings considerably enhance the general appearance of the buildings and grounds.

The shops are located on the west side of the main tracks from St. Augustine to Jacksonville. Cars may be brought into the shops from either direction and switched to the west end of the transfer table. However, the usual procedure is to switch cars into the coach-shop yard from the south end.

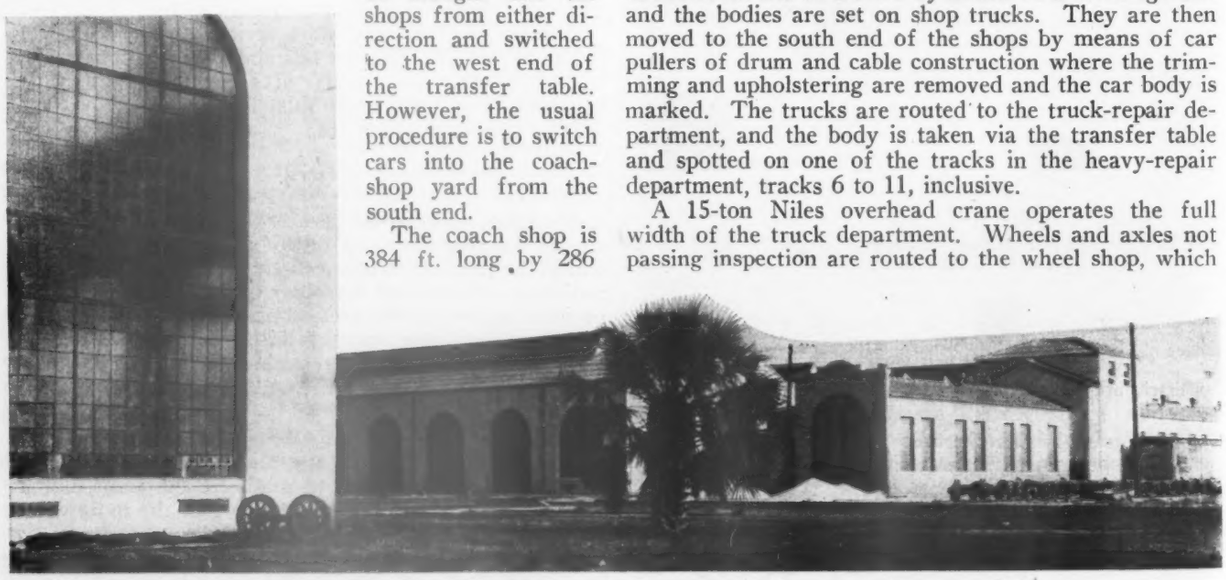
The coach shop is 384 ft. long by 286 ft. wide. A partition wall divides the building into two parts, the repair shop being located on the west side and the paint shop on the east. Eight-foot concrete roadways are provided, as shown in the drawing, for the trucking and handling of materials.

A coach storage shed, 288 ft. long by 73 ft. wide, is located south of the coach repair shops. Five tracks lead into this building from a ladder track which is a continuation of track 15 from the east side of the paint shop. A building for sand-blasting is located on the west side of the coach shops on track 2 leading to the transfer table. It will be observed from the drawing showing the layout of the shop tracks and buildings that the facilities for handling coach repairs are well arranged and convenient for the production of all classes of repairs.

Routing Cars Through the Shop

Cars requiring body and truck repairs are brought into the shop over tracks 1, 3 or 4 and moved via the transfer table to track 5 in the coach repair shop. The tracks in both the repair and paint shops are spaced 22 ft. apart, center to center. The coaches are unwheeled at the north end of track 5 by means of a Whiting hoist and the bodies are set on shop trucks. They are then moved to the south end of the shops by means of car pullers of drum and cable construction where the trimming and upholstering are removed and the car body is marked. The trucks are routed to the truck-repair department, and the body is taken via the transfer table and spotted on one of the tracks in the heavy-repair department, tracks 6 to 11, inclusive.

A 15-ton Niles overhead crane operates the full width of the truck department. Wheels and axles not passing inspection are routed to the wheel shop, which



Miller coach shops—Sand-blast building and wheel storage at the right

is located west of the locomotive shop, as shown in the drawing.

The coach repair department is served by ½-ton chain hoists hung from mono-rail trolleys. Two hoists are provided for each mono-rail, one of which extends along each side of each repair track. Adjustable scaffolding of steel construction is installed along each of the repair tracks.

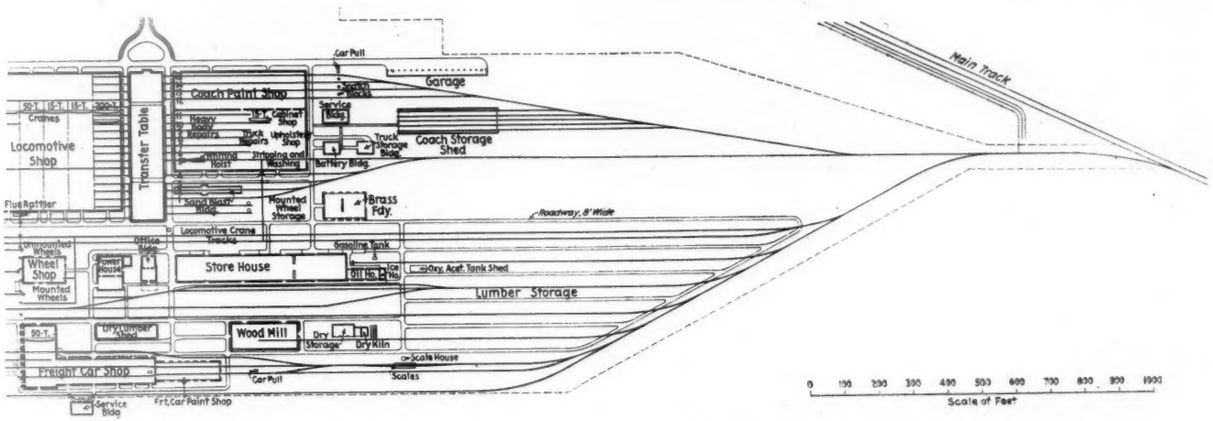
A feature of the facilities provided for the coach-repair department is a frame for straightening car frames and steel body sides. This frame consists of 14 perpendicular columns, seven on each side, placed along track 5 at the south end of the pit at the Whiting hoist. The columns are heavy channel sections connected by horizontal steel-channel sections, laid underneath the track in 8 in. of concrete, to the column directly opposite. Frames are straightened by means of jacks placed between the columns and the side of the car or frame.

The carpenter, pipe, blacksmith and electrical shops are arranged along the west side of the shops between the outside wall and track 5. The car washing floor at the south end of track 5 slopes to two drains between the west wall and track 5 and to two drains located between the rails. The upholstery shop is arranged along the south wall between track 5 and the center partition wall. The cabinet shop, tool room and trim shop occupy the bay between the upholstery and truck shops.

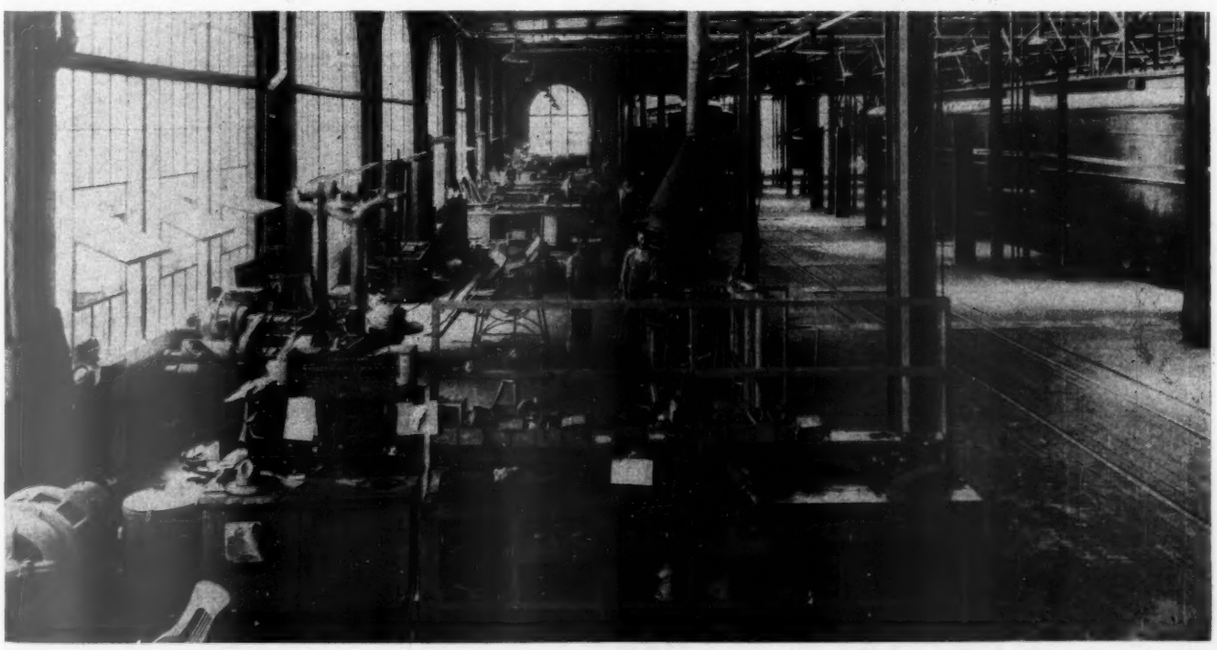
The Paint Shop

Coaches to be repainted are moved from the washing floor to the paint shop via track 5. Steel cars in bad condition are sandblasted and primed with metal frames. This is followed with three coats of Glidden surfacer. The primer coat is allowed to stand for 36 hr. Twenty-four hours are allowed between coats of surfacer.

The final surfacer coat is rubbed down with wet and dry sandpaper, after which two coats of Flood & Conklin Simplex coating, Pullman finish color, are applied. The cars are lettered with gold leaf after which three coats of varnish are applied. The entire exterior ap-



Layout of the car-department repair facilities at the Miller shops of the Florida East Coast



Interior of the coach repair shop—The columns for straightening frames are shown in the background

plication is made by the spray process, with De Vilbiss equipment.

The interior of the cars are also sandblasted. Two coats of lead are sprayed over the interior which is followed by paint in two shades of gray, also applied by the spray process, which is used for all paint work, including the trucks. Ceilings of coaches are finished in light gray. The ceilings of baggage cars are painted white with the side walls done in ochre enamel.

Sash and furniture is burnt off when necessary and built up with wood primer. One coat of wood primer is applied, followed by two coats of surfacer, which is rubbed, two coats of color and two coats of varnish.

List of Machine Tools and Equipment in the Miller Coach Shops of the Florida East Coast Line at St. Augustine

UPHOLSTERY DEPARTMENT

Number	Manufacturer and Size	Kind of Machine
3	.....	Sewing machines
1	.....	Curtain cleaning vat
1	.....	Seat and cushion cleaning and drying outfit
1	.....	Carpet rack
1	Atlas	Hair picker

PATTERN DEPARTMENT

Number	Manufacturer and Size	Kind of Machine
1	Fay & Egan.....	Patternmakers' lathe
1	Fay & Egan.....	Jib saw
1	Universal, No. 6-E.....	Wood trimmer
1	.....	Pattern-number former

BLACKSMITH DEPARTMENT

Number	Manufacturer and Size	Kind of Machine
1	.....	Forge
1	.....	Anvil
1	.....	Power hammer
2	.....	Face plates

WOOD WORKING DEPARTMENT

Number	Manufacturer and Size	Kind of Machine
1	Fay & Egan, No. 418.....	Gainer
1	Fay & Egan.....	Saddle gainer
1	Fay & Egan, 48 in.....	Band saw
1	Fay & Egan, No. 500	Rip saw
1	Oliver, No. 2.....	Wood trimmer
1	Oliver, No. 3.....	Wood trimmer
1	Fay & Egan	Wood lathe
1	Fay & Egan, No. 454	Disc sander
1	Fay & Egan, No. 224, 24 in.....	Surfacer
1	Fay & Egan, No. 264	Rip saw
1	Fay & Egan	Cut-off saw
1	Fay & Egan, No. 209.....	Universal wood worker
1	Fay & Egan, No. 214.....	Hollow chisel mortiser
2	.....	Bench planers
1	Fay & Egan, No. 505.....	Tenon machine

TOOL ROOM

Number	Manufacturer and Size	Kind of Machine
1	.....	Band saw filing machine
1	Mummert, Dixon Co.....	Tool grinder
1	Fay & Egan	Planer knife grinder
1	Ranson	Dry grinder

STEEL WORKING DEPARTMENT

1	..... Three-head	Bolt threader
2	Berwick	Electric rivet heaters
1	Cincinnati Shaper Co.....	Forming press
1	Fay & Egans, No. 50.....	Metal band saw
1	Pels	Punch and shear
1	American, 3-ft.....	Radial drill
1	Cincinnati	High-speed drill press
1	Aurora, 32-in.	Drill press

TRUCK DEPARTMENT

1	Niles, 15-ton	Over-head traveling crane
1	.....	Spring tester
1	Watson-Stillman, 30-ton.....	Press

PIPE DEPARTMENT

1	Landis, 4-in.....	Pipe threader
1	Underwood	Pipe bender
1	.....	Forge
1	.....	Anvil

SHEET METAL DEPARTMENT

1	Dreis & Krump, 10-ft.....	Brake
1	..... 3-ft.	Forming rolls
1	..... 8-ft.	Cornice brake
2	Peck, Stow & Wilcox	Circle shear
1	Peck, Stow & Wilcox, 36-in.	Hand brake
2	Peck, Stow & Wilcox	Hand shear
1	Peck, Stow & Wilcox, 52-in.	Squaring shear
1	Peck, Stow & Wilcox, 36-in.	Squaring shear
1	Peck, Stow & Wilcox, 54-in.	Rolls
1	Peck, Stow & Wilcox, 48-in.	Foot brake
1	Peck, Stow & Wilcox	Hand punch
1	Peck, Stow & Wilcox, 30-in.	Bending rolls
1	Peck, Stow & Wilcox, 30-in.	Bar folder
1	Peck, Stow & Wilcox	Combination former
4	.....	Revolving machine standards
1	Marshalltown	Throatless shear

GENERAL EQUIPMENT IN COACH REPAIR AND PAINT SHOPS

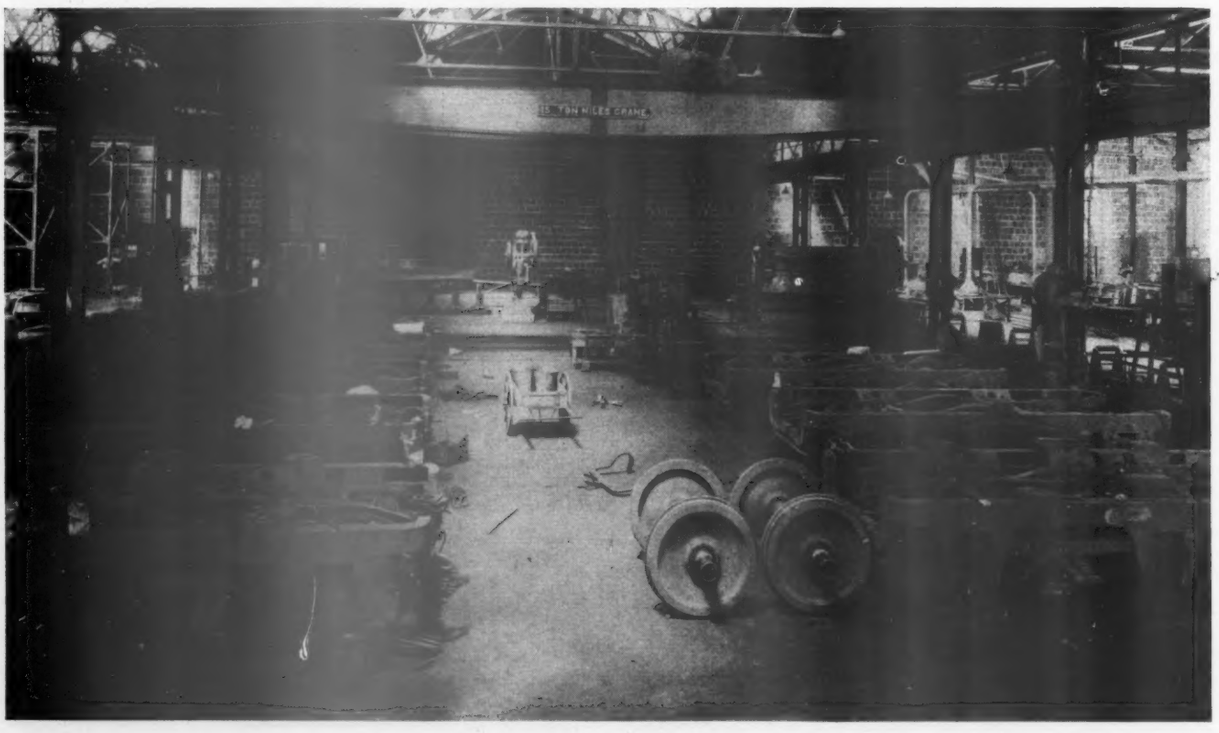
1	Whiting electric.....	Coach hoist
2	Godfrey	Car pullers
1	.....	Set straightening frames

PAINT SHOP EQUIPMENT

1	DeVilbiss	Paint spraying system
1	Gehnrich	Enameling oven

ELECTRIC DEPARTMENT

1	General Electric	Motor generator set



The truck-repair department

The wheel shop—Unmounted wheels are brought into the shop through the door at the right

Enameled toilet hoppers and basins are sandblasted after which two coats of undercoating are applied followed by two coats of white-enamel finish. They are then baked for three hours in a Gehnrich indirect-heat oven at 200 deg. F.

Eight painters working on car bodies and four men in the sash department turn out three cars per week. Cars are moved in and out of the paint shop with a cable car puller.

The Wheel Shop

The wheel shop is located west of the locomotive shop, as shown in the drawing. It is 72 ft. wide by 120 ft. long and of the same design and construction as the coach shop. Unmounted wheels are stored in the area east of the wheel shop, while mounted wheels are

Niles car-wheel lathe in the wheel shop

stored in the area opposite or west of the building. In addition to wheels removed in the coach and freight-car departments at Miller shops, the wheel shop maintains wheels for the entire system.

Wheels, on being unloaded, are cleaned and given an A.R.A. inspection. All wheels marked OK by the inspector on the line are checked on arrival at the wheel shop, where they are taped, remated and mounted. It is estimated that remating wheels saves the road from $6,000 to $7,000 annually. Occasionally wheels marked OK by an inspector will not pass the wheel-shop inspection. Such wheels are set to one side and stored until inspected by the car inspector who then takes the matter up with the inspector who marked the wheel OK.

List of Machine Tools and Equipment in the Miller Wheel Shops of the Florida East Coast Line at St. Augustine

Number	Manufacturer and Size	Kind of Machine
1	Pond	Double axle lathe for rolling journals
2	Niles, No. 2	Double axle lathes
1	Betts, 52-in.	Car-wheel borer
1	Niles, 48-in.	Car-wheel borer
1	Hisey-Wolf	Emery grinder
1	Niles, No. 3	Car-wheel lathe
1	Niles, 400-ton	Wheel press
1		Wheel-starting press

Axles are removed and handled separately by monorail through the wheel shop. If calipering shows the wheel fits to be oversize, the operator of the wheel borer is informed and wheels are bored accordingly. All axles are placed in a lathe to test for straightening before they go out of the shop. All journals are rolled and polished.

THE FIRST RAILROAD in the Mississippi Valley and one of the first railroads in the world to adopt the standard gage was the West Feliciana Railroad, between St. Francisville, La., and Woodville, Miss., now a part of the Illinois Central.

This railroad will soon reach its 100th birthday. It was chartered by the state of Louisiana on March 25, 1831. At that time railroads were in the experimental stage and there was much controversy among railway engineers in England and the United States concerning the most practical gage to adopt. George Stephenson, the inventor of the locomotive, was advocating a gage of 4 ft. 8½ in.; Brunel, another noted engineer, was building a railroad with a 7-ft. gage, the broadest railroad the world has ever known. In the United States there were railroads building and proposed with gages of 4 ft. 9 in., 4 ft. 9¼ in., 4 ft. 10 in., 5 ft. and 5 ft. 6 in. The first Southern railroad, in South Carolina, had a gage of 5 ft.

At the time the West Feliciana Railroad was organized in 1831, there were only two or three short railroads in England of 4 ft. 8½ in. gage and one in the United States—the Baltimore & Ohio, then only a few miles long. It was not until after the Civil war that 4 ft. 8½ in. became the standard gage for steam railroads in the South.

Stug System of Firing Pulverized Fuel*

By R. Roosen

BOTH of the 2-10-0 type locomotives built with the Stug system for the German State Railways described in the March issue were first tried on several runs on the German State Railways' lines near Kassel. Thus schedule freight trains were hauled on the section from Kassel to Eichenberg, which has numerous curves and long inclines of 1 in 100. The weight of these trains was about 1,200 to 1,300 tons. On level track it was generally possible to run with only one burner in action, while on the heavy gradients, when both burners had to be operated, the locomotive was working at its full output of about 1,400 hp. at the tender drawbar.

These trial runs fully demonstrated that the locomotives came up to all expectations as to their adaptability to running conditions, simplicity of operation, and reliability of the pulverized-fuel burning equipment. Full steam pressure could easily be maintained, and there was no difficulty in preventing steam from blowing off when passing from gradients to level or down grades. When running down steep gradients, both of the burners could be cut out, so that the auxiliary burner alone was in operation. When restarting the main burners, ignition was readily made by the auxiliary burner flame.

These trial runs were carried out on lignite dust developing about 9,000 B.t.u. per lb. Combustion of the dust was perfect, the flue gases emitted through the chimney were colorless, and even on night runs no sparking was observed. Even while the locomotive was running very slowly, so that the exhaust puffs succeeded each other at relatively long intervals, there was an unimpeded flow of the flue gases.

On the strength of these results, one of these locomotives was assigned in May, 1929, to the Halle district of the German State Railways, where it has been in service ever since, with a considerable saving of fuel and furnishing a valuable occasion for collecting road experience. Particulars in this respect will be given in connection with other G-12 class engines adapted for the Stug system later and likewise assigned to the Halle district. The economical success achieved will also be dealt with.

The other of these two locomotives was submitted to a series of thorough trial runs by the German State Railways' testing department at Grunewald (near Berlin), during the summer and fall of 1929. On such trial runs, the locomotive is coupled to a dynamometer car with a brake locomotive in the rear. The brake locomotive compresses air in its cylinders, which is exhausted through the chimney, so that the resistance can be adjusted to any desired amount. The locomotive under trial can therefore be examined with constant output and for any distance, independent of road conditions. All factors of interest, such as fuel and water consumption, boiler efficiency, temperature, and composition of

* Part II of the report on the Stug system of firing pulverized fuel.

Longitudinal section and side view of a Stug 2-10-0 type locomotive of latest design

nue gases, can thus be checked at various speeds and compared with each other. The runs were made under conditions varying from no-load to top boiler output of 12.3 lb. per sq. ft. per hour. The dust consumption is determined by weighing the tender before and after the run.

The rate of coal-dust consumption and the boiler efficiency gave entirely satisfactory results. In all of these runs, the whole of the air required for combustion was injected through the burners (primary air supply), an improvement of the boiler efficiency being expected as against drawing part of the air direct through the ashpan into the firebox (secondary air supply). It was indeed possible to reduce the excess of air in combustion to about 20 per cent, corresponding to a CO_2 content of about 15 per cent, combustion being very satisfactory. It appeared, however, that with varying loads as experienced in actual service the advantage of introducing 100 per cent of the air for combustion as primary did not amount to much. Therefore, simultaneously with the trials of the first two locomotives by the State Railways, the Stug proceeded with a series of experiments on its test plant at Kassel, during which part of the air was blown through the burners and the remainder was drawn in through the ashpan. This method was necessary for the burning of hard-coal dust, which was then under trial at Kassel, and it furnished conclusive results also with lignite dust. On the basis of these results obtained at Kassel, the Grunewald locomotive was submitted to another series of tests with part of the air drawn in through the ashpan. The results were nearly the same as in the former series of tests, that is, entirely satisfactory. In order to furnish a basis for comparison with a conventional type locomotive, a normal grate-fired class G-12 locomotive was put to test under the same conditions. The boiler efficiency of the coal-dust fired locomotive was around 78 per cent under all loads, which, in the case of top load, was about 9 per cent above the grate-fired locomotive, while with small loads there was less difference. The heat expenditure in the fuel, related to the drawbar horsepower, was accordingly 9 per cent lower with peak loads. The steam consumption of the auxiliary machines on the tender is of course included. It amounted to about 5 per cent of the steam generation of the boiler. The combustion of the dust was complete. The composition of the flue gases will be seen from Table III, which gives figures obtained in the course of trials made with the Stug system under loads as applied during the Grunewald runs. After these tests had been carried out to entire satisfaction, the Grunewald locomotive was also assigned to the Halle district for regular service.

While the two aforementioned locomotives were undergoing trials by the State Railways, experiments on the test stand at Kassel were continued. The aim was to ascertain to what extent manufacturing could be simplified and cheapened. The tests chiefly bore on the possibility of driving the blowers and conveyor worms by one turbine, thus eliminating the steam motor which had been provided at the State Railways' request for the worm drive. It appeared that this simplified drive succeeded well if the air and dust supply were regulated so as to give a correct proportion at any turbine speed. Control of the furnace output from top load to minimum load (a range of about 1 to 8) was also obtained by just varying the turbine speed, one burner being cut out in the case of smaller loads. The auxiliary burner worm and blower, too, could be dispensed with in this way, since no-load performance of the engine could be maintained with one main burner in gear at reduced turbine speed. The equipment was thus greatly simplified.

In the course of these trials, which were made with a view to obtaining greater simplicity, the behavior of the ash was given further attention. It is known that the larger part of the ash is carried away through the stack, the remainder, however, remaining in the ashpan. A perfect pulverized-fuel firing system must avoid the formation of troublesome honeycombing on the tube sheet. This important problem, therefore, may be given more detailed consideration.

The tendency of the ash to form deposits depends on the temperature at which it will begin to soften and fuse. The combustion in the furnace, therefore, must be accelerated so that the ash will have cooled down below these temperatures before it hits the tube sheet. The temperature limit for this purpose lies between 1,940 and 2,480 deg. F. for most types of coal. As it appeared from the tests, such acceleration is obtained by using dust ground to a sufficient degree of fineness, ensuring a perfect mixture of the dust and primary air, adequately timing the air supply to the firebox, a perfect mixture of the gases with the secondary air, and in the case of coal with little volatile constituents a certain preheating of the primary air by exhaust steam from the tender turbine. In this way the Stug succeeded in avoiding honeycombing totally, or at least to such an

Table III—Tests Made in the Mittelfeld Testing Plant on Lignite Fuel

Date	10–11–29	1–10–10	9–25–29	8–29–29	1–9–30	10–18–29
Test No.	25	34	18	15	33	28
Lower heating value, B.t.u. per lb.	9,604	9,366	9,364	9,432	9,366	10,052
Residues on 170-mesh screen, per cent	23.96	17.60	17.18	19.20	17.60	28.32
Fuel consumed, lb. per hour	1,415	2,000	3,197	3,792	4,520	4,211
Firebox heat output, B.t.u. per cu. ft. per hour	0.606×10^5	0.836×10^5	1.33×10^5	1.6×10^5	1.89×10^5	1.895×10^5
Evaporation, lb. per hour	9,017	12,081	19,048	23,149	26,279	26,522
Temperature of feedwater, deg. F.	208	201	210	217	205	212
Coefficient of evaporation	6.37	6.04	5.97	6.10	5.82	6.30
Evaporation of heating surface, lb. per sq. ft. per hour	4.32	5.80	9.12	1.11	12.6	12.68
Boiler pressure, lb. per sq. in.	201.9	199.1	200.5	201.9	201.9	201.9
Average temperature of superheated steam, deg. F.	639	651	714	711	738	741
Average temperature of flue gas in smokebox, deg. F.	554	576	639	642	705	709
Analysis of flue gas: CO_2, per cent	13.2	13.0	12.9	14.8	13.8	14.4
Analysis of flue gas: O_2, per cent	6.0	6.4	6.4	4.4	5.6	5.0
Analysis of flue gas: CO, per cent	0.0	0.0	0.0	0.1	0.1	0.1
Boiler efficiency, determined from flue-gas losses, per cent	77.2	76.2	76.7	77.2	75.8	76.0
Free heating surface in firebox (not brick-lined), sq. ft.						131.6
Heating surface in tubes, sq. ft.						1945.1
Total heating surface, sq. ft.						2076.7
Firebox capacity, cu. ft.						211.9
Free heating surface in firebox (sq. ft.) / total heating surface (sq. ft.)					$= \frac{131.6}{2076.7}$	$= \frac{1}{15.8}$
(Firebox capacity (cu. ft.) / total heating surface (sq. ft.)					$= \frac{211.9}{2076.7}$	$= \frac{1}{9.79}$

extent that no trouble was experienced with it. It is noteworthy that these results were obtained in the small firebox of the German State Railways' G-12 class locomotive in which a firebox output of 235,000 B.t.u. per cu. ft. is produced with top loads. It is obvious that conditions must be more favorable with American locomotives having a larger firebox volume and often a combustion chamber. With such designs, temperatures can be kept so low that the inconvenience of honeycombing is easily avoided.

These investigations were instrumental in proving that hard coal and many types of foreign coal, such as Brazilian, Austrian, and Russian, which may be available for pulverized-fuel firing, can be fired to full advantage, the preceding Stug tests having demonstrated that the problem was solved in every respect so far as lignite dust was concerned. (See Table IV, referring to tests with hard coal.) In these hard-coal tests, the burner head was slightly modified where it joins the firebox, and the primary air was preheated to about 200 deg. F. by exhaust steam from the turbine. The hard coal used had no more than about 20 per cent of volatile constituents.

Similar results were obtained in burning dust from low-temperature lignite coke having only about 10 per cent volatile constituents.

As mentioned before, these tests, the purpose of which was the extension of pulverized-fuel firing to types of coal other than lignite, were carried out simultaneously with the trial runs of the first two lignite-

Table IV—Tests Made in the Mittelfeld Testing Plant on Hard Coal

Date	4–29–30	4–15–30	6–27–30	7–16–30	8–1–30	8–5–30	8–7–30
Kind of coal	Silesian coal				Ruhr coal		
Lower heating value, B.t.u. per lb.	12,184	12,184	13,605	13,605	13,618	13,618	13,618
Volatine constituents, per cent	29.9	29.9	21.1	21.1	20.08	20.08	20.08
Fuel consumed, lb. per hour	2,482	3,395	630.5	1,592	1,951	2,535	2,954
Firebox heat output, B.t.u. per cu. ft. per hour	1.42×10^5	1.94×10^5	0.402×10^5	1.01×10^5	1.25×10^5	1.62×10^5	1.89×10^5
Evaporation, lb. per hour	19,941	26,015	6,601	14,661	18,129	22,995	26,191
Temperature of feedwater, deg. F.	212	214	212	212	212	210	212
Coefficient of evaporation	8.04	7.66	10.45	9.22	9.29	9.08	.832
Evaporation of heating surface, lb. per sq. ft. per hour	9.59	12.52	3.18	7.05	8.73	11.07	12.6
Boiler pressure, lb. per sq. in.	193.4	193.4	192.0	197.7	197.7	197.7	196.2
Average temperature of superheated steam, deg. F.	595	649	satd. steam	561	530	571	601
Average temperature of flue gas in smokebox, deg. F.	583	651	435	523	529	564	577
Average CO_2 contents of flue gas, per cent	13.1	13.6	11.4	12.7	12.0	12.8	12.5
Temperature of primary air in burner, deg. F.	173	172	183	176	170	164	161
Boiler efficiency based on a loss of heat of 12 per cent	75.0	73.2	78.4	76.1	75.2	75.1	74.1
Free heating surface in firebox (not brick-lined), sq. ft.							131.6
Heating surface in tubes, sq. ft.							1945.1
Total heating surface, sq. ft.							2076.7
Firebox capacity, cu. ft.							211.9
Free heating surface in firebox (sq. ft.) / total heating surface (sq. ft)						$= \frac{131.6}{2076.7}$	$= \frac{1}{15.8}$
Firebox capacity (cu. ft.) / total heating surface (sq. ft.)						$= \frac{211.9}{2076.7}$	$= \frac{1}{9.79}$

dust-fired Stug locomotives on the German State Railways' lines. The experience collected by these further tests made at Kassel, and in particular the simplifications of equipment described, were of course taken advantage of in the construction of the further locomotives which were adapted for coal-dust firing by Henschel & Sohn on the German State Railways order, on the strength of the good results they had obtained with the two first ones.

These further State Railways' locomotives again were of the G-12 class, it being required to increase the bunker capacity of the tender while maintaining the original tender frame. This increase, from 6.4 to 11 tons, was achieved by suppressing the steam-motor and auxiliary-burner equipment. The tender tank is of the water-leg type, as in the previous locomotives. The blowers supplying the primary air are arranged on top of the tender tank at the rear end of the engine. The blower casing is cast solid with the turbine casing, which ensures sturdy construction. The turbine shaft, by means of a worm gear, drives a vertical shaft extending downward through the water tank, the latter shaft operating the two dust conveyor worms by a bevel and spur-wheel gear. The gearing reduction is about 1 to 30, the conveyor worms rotating at a maximum of 150 r.p.m. The worms are located in two trough-shaped castings forming the bottom of the bunker and affording perfect alignment of the worm bearings. The air current from the blowers encloses the trough in three-quarters of a circle and picks up the dust at the worm outlet, whence it is conveyed toward the burners through two pipe couplings having ball joints and stuffing boxes. The burners are again located below the firebox back plate. The ashpan casing is fitted with inlets for giving access to the secondary air. The size and number of these inlets depend on the type of coal used, one slot below the brick arch being quite sufficient for lignite. The brick arch extends inward to about one-half of the firebox length, thus producing an S-shaped flame. In order to remove such deposits as may form on the tube sheet owing to an occasional supply of inferior or too coarse-grained dust, an ash-blower is provided in the firebox back plate. It will be useful for cleaning the boiler in such cases and also can be operated while the locomotive is running if necessary. Otherwise the locomotives have not been modified as against the conventional G-12 class, there being only the addition of a steam connection at the dome for the turbine on the tender. Of course, the blast pipe was adjusted so as to produce sufficient draft for drawing the secondary air supply into the firebox, a pressure of 4.2 lb. per sq. in. of the exhaust steam in the blast pipe being the maximum required at top output.

The control of the engine is exceedingly simple. The fireman has but to regulate the supply of steam to the tender turbine by turning a single handwheel, thus varying the quantity of fuel and primary air. The ingress of secondary air is controlled by a valve in the ashpan. This clearly demonstrates the relief to the fireman as against grate-fired locomotives. The dust conveyor worms are clutched and declutched by two ratchet levers conveniently arranged on the fireman's side. The air and dust supply systems are again so interlocked as to make them foolproof; i.e., it is impossible to start the conveyor worms without first producing an air current to carry the dust into the firebox.

Careful investigations have been made by Stug with a view to ascertaining whether it would be advisable to

grind the fuel on the tender. The result, however, was that at present serious difficulties would be experienced in trying to design a mill to combine light weight, reduced volume, economy and reliability to such an extent as would be required in view of the limited space on the tender and the considerable variation in locomotive output.

It is noteworthy that during the whole running period there was not a single case of self-ignition or spontaneous combustion. There is, however, every reason to believe that, even if such an occurrence should come to pass in the tender bin, there would be no danger, as the glowing dust could be blown into the firebox.

Caking of the fuel in the tender bin was not experienced. In order to counteract arching of the dust, some upturned whirling nozzles in the sloping sides of the bin were provided. It was, however, hardly necessary to resort to them.

In firing up a coal-dust-fired locomotive from cold, steam of 75 to 85 lb. per sq. in. pressure is taken either from a pipe line in the enginehouse or from another locomotive under steam, the connection being made through the steam-heating pipes of the locomotive. This will start the tender turbine and set the blower ring on the exhaust pipe of the engine to work, the dust and fuel mixture entering the firebox being ignited by a wood or cotton-waste fire. Once the steam pressure in the locomotive boiler has risen to about 80 lb., it will furnish the supply for further steam raising, and the outside source can be dispensed with. The time for thus steaming a pulverized-fuel burning locomotive is considerably shorter than in the case of a grate-fired locomotive.

It will be interesting to note that all of the auxiliary machines have acquitted themselves very well in nearly two years' road service. The conveyor screws were never clogged up. A fact deserving particular mention is that the holes in the burner plates were neither clogged nor worn by the impact of the dust and that the air cooling has been entirely sufficient as provided.

Experience with the brick lining was satisfactory, only little repair work being necessary.

While working safety was thus always on a high level, it may yet be permitted to inquire as to what happens if one of the worms or burners fails. In this case the locomotive can be operated at reduced performance on the other burner. The risk in this respect is, however, no greater than that of the two boiler-feed devices of a locomotive failing simultaneously. How seldom this happens is well known.

The Stug's research work has established that slack dust, too, has a bright outlook in Germany on account of the difference in price between lump coal and slack. This justifies a favorable forecast also in respect to locomotives fired with slack dust. This will be particularly appreciated for application to high-pressure locomotives, toward which there is a strong tendency, and which, on account of their small water spaces, make an easily adjustable fire control desirable.

4-6-4 Type Locomotives On the Canadian Pacific

(Continued from page 171)

the stoker engine. The suction line heater has a 3/8-in diameter pipe.

The locomotives are equipped with American multiple throttles. The connecting rod from the throttle-shaft connection to the lever in the cab is placed in the handrail along the right side of the boiler. The throttle lever is easy to operate and can be set to any notch on the quadrant with little effort. No compensating lever is used.

The valves are actuated by a Walschaert gear. This is designed with a short throw of the eccentric and with a long link. It has small working angles, the object of which is to secure an easy and smooth working valve motion. The engines are fitted with screw reverse gears.

One of the illustrations shows a class H1b locomotive under construction in the shop before the rods have been applied. The main drivers have not been painted and clearly show the counterbalance weights as they have been compensated previous to application. All driving wheels are carefully checked in the shops on a balance table so as to secure minimum variations in counterbalance weights. Cross counterbalancing is used in the main wheels, but is not considered necessary in the leading and trailing wheels. Forty per cent of the reciprocating weights are balanced, which is distributed over all the wheels.

The engine truck is of Commonwealth design constant-resistance type. Its journals, as well as those of the tender trucks, are equipped with SKF roller bearings. The trailer truck is fitted with floating liners and one engine is fitted with SKF roller bearing trailer truck for experimental purposes.

The locomotives have Commonwealth cast-steel beds with the main cylinders and air reservoirs cast integral. The connection between the engine and tender is of the Franklin unit-drawbar type utilizing the railway company's standard laminated drawbars and also the Franklin special wedge type E-1 radial buffer, all of which were described in the March, 1929 issue of the *Railway Mechanical Engineer*, page 123.

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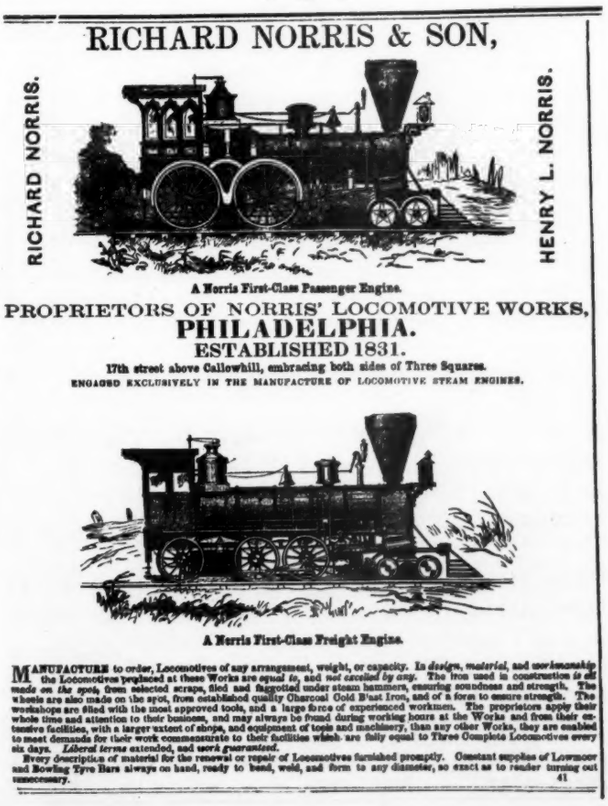

RICHARD NORRIS & SON,
RICHARD NORRIS.
HENRY L. NORRIS.
A Norris First-Class Passenger Engine.
PROPRIETORS OF NORRIS' LOCOMOTIVE WORKS,
PHILADELPHIA.
ESTABLISHED 1831.
17th street above Callowhill, embracing both sides of Three Squares.
ENGAGED EXCLUSIVELY IN THE MANUFACTURE OF LOCOMOTIVE STEAM ENGINES.
A Norris First-Class Freight Engine.
MANUFACTURE to order, Locomotives of any arrangement, weight, or capacity. In design, material, and workmanship the Locomotives produced at these Works are equal to, and not excelled by any. The iron used in construction is all made on the spot, from selected scraps, fired and faggoted under steam hammers, ensuring soundness and strength. The wheels are also made on the spot, from established quality Charcoal Cold Blast Iron, and of a form to ensure strength. The workshops are filled with the most approved tools, and a large force of experienced workmen. The proprietors apply their whole time and attention to their business, and may always be found during working hours at the Works and from their extensive facilities, with a larger extent of shops, and equipment of tools and machinery, than any other Works, they are enabled to meet demands for their work commensurate to their facilities which are fully equal to Three Complete Locomotives every six days. Liberal terms extended, and work guaranteed.
Every description of material for the renewal or repair of Locomotives furnished promptly. Constant supplies of Lowmoor and Bowling Tyre Bars always on hand, ready to bend, weld, and form to any diameter, so exact as to render turning out unnecessary. 41

Advertising typical examples of the locomotives builders art in the *American Railroad Journal* during 1855

Condensed Mechanical Data For Car Department Reference

Herein is described a pocket-size book comprised of blue-printed pages which contain condensed tabulations of car series and the repair parts most often called for—Detailed references of standard equipment and standard practices are also given to facilitate repairs and to expedite the movement of cars through large and small shops

By P. P. Barthelemy

IN the handling of car repairs, the lack of readily accessible information relative to the identity of a repair part or parts standard to any particular car is often a serious handicap and one which is frequently encountered. This applies chiefly to the more generally used items, such as couplers, coupler yokes, draft-gear parts, sill steps and truck repair parts, such as bolsters, side frames, arch bars, brake hangers, etc.

In the absence of a very intimate knowledge of detail standards or of readily available reference data, more or less extensive identification measurements must be made, or, where available, reference must be made to a usually cumbersome set of blue prints. At small repair points complete blue-print information is usually lacking. In either event there is an appreciable loss of time to the workmen, as well as to the supervisor, and possibly of service time to the car, which in the aggregate runs into a considerable monetary loss.

For home cars such losses may be almost entirely eliminated. In the case of foreign line cars, much of this is unavoidable, but if information relative to a

	KIND	LGTH/CAPY	WT. CWT.	BUILT	BRK. CYL.	DRAFT GEAR	YOKE	FOLLOWER	COUPLER	DRAFT SPRINGS	BRK. SHFT.	HAND BRAKE	SIDE BEARING	TRUSS ROD	TR. RD. END	CENT. PIN	SILL STEP	TRUCK BOLSTER	SPG. PLK.	BRK. HGR.	BRK. BEAM	TRK. SPG.	ARCH BARS TOP	ARCH BARS BOT.	ARCH BARS TIE	BOT. ROD	SD. DOOR	END
3000-5999	B	40/80	424	SUF '25 & '27	10"	CAPD.G25	25	-	6/8-D	393-4	12'-11"	PL	FR	1 5/8-8	10 5/8	2-3	B	13"	1	2T	343 6	43	44	45	2	B 5'-6"	W D
6000-7999	"	"	"	" '28	"	SESS. K4	"	16 2	"	601-2	"	"	"	" "	"	"	"	"	"	"	"	"	"	"	"	"	"	" "
8000-8499	"	36/60	350	" '26	8	CARD.G25	"	-	"	393-4	11'-6"	"	"	" 6	"	"	"	"	20	2C	" 4	152	153	154	"	5'-4"	" "
8900-8999	HOP B	40/80	439	SUF '29	10	CARD-SESS	25	16	6/8-D	393-4 601-2	12'-11"	PL	FR	1 5/8-8	10 5/8	2-3	B		1	2T	343 6	43	44	45	2	B 5-6	W D
9000-9999	B	"	437	" GN '25	"	CARD.G25	"	-	"	393-4	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	} -
10000-12897	"	"	348	B '01, '02	8	BRAD 6/8	26	-	5/7-6 1/2 D	378-9	11'-6"	"	"	"	"	1	"	"	"	"	"	"	"	"	"	"	"	W D
13000-17276	"	"	424	SUF '30	10	CARD G25	25	-	6/8-D	393-4	12'-11"	"	"	"	"	2-3	"	"	"	"	"	"	"	"	"	"	"	" "
17277-18762	"	"	387	B '12 I 3 [C 9"	"	WP 8/8	17	9	5/7-9 3/8 D	380-1	11'-6"	"	"	"	"	1	"	"	"	"	"	"	"	"	"	"	"	" "
22744-23493	"	"	428	WSCF '17 SUF '29	"	CARD-SESS	25	-	6/8-D	393-4 601-2	12'-11"	"	"	"	"	2-3	"	PS	2	"	"	BETT CT	443		"	"	" "
23494-24993	"	"	457	MT. V. '19	"	SESS K4	"	16 2	"	601-2	11'-10"	"	WN	-	-	12	USS 1412	13]	3	2C	350-1 4	USS	1409		3	NFL 6'0"	} -
24994-25993	"	"	441	PUL. '23	"	CARD.G25	"	-	"	393-4	"	"	"	-	-	"	"	"	"	"	"				"	"	C332 6'-0"	} -
31000-31499	B	40/100	482	GN '27	10	MIN.A79X	25	16'	6/8-D		13'-1"	PL	OO.T BARB	-	-	24	BSCCo B-592	13]	3	2C	350-1 4	DAL	BSF	549	3	C-32 6'-0"	} D
43000-43399	A	50/80	546	GN '27	10	CARD.G25	25	-	6/8-D	394-4	13'-3"	PL	OO.T BARB	-	-	19	B	13]	1	2T	343 6	43	44	45	2	C-50 10'-0	} D
43400-43499	"	"	"	"	"	"	"	-	"	"	"	"	"	-	-	"	"	"	"	"	"	"	"	"	"	"	"	} AU E.D.
43500-43899	"	50/100	559	GN '29	"	MIN.A79X	"	16'	"		"	N.M.-H	"	-	-	"	ASF 764-2L	PS	3	2C	350-1 6	DAL	ASF	7859	3	C-50 12'-0	} D
43900-43999	"	"	560	"	"	"	"	"	"		"	"	"	-	-	"	"	"	"	"	"		"		"	"	} AU E.D.
57600-57999	S	36/80	390	SUF '28	8	SESS. K4	25	16 2	6/8-D	601-2	11'-6"	PL	FR	1 5/8 8	10 5/8	23	B	13]	1	2T	343 6	43	44	45	2	B	W B-S
58000-58499	"	"	380	PUL '22 STEEL	10	CARD.G25	"	-	"	393-4	"	"	"	-	-	23	"	"	4	2C	"	146	147	148	3	"	"
65000-65499	F-S	52/100	423	S.S. '28	10	CARD.G25	25	-	6/8-D ROTOR	393-4		J M Co	OO-T BARB	-	-	12	ASF 7642-A	PS	3	2C	350-1 6	DAL	7859		3	-	-
69500-69999	LOG	43/100	385	S.S. '29	"	MIN.A22X	"	16'	"			URECo	"	-	-	"	B 592	"	3	"	" 7	DAL	F547		"	-	-
77000-77249	G	40/140	504	P.S. '27	"	CARD.G25	"	-	6/8-D	393-4	10'-0"	MIN. LEVER	"	P.S. DUMP		8-9	D	"	"	"	350-1	DAL	S.C.O.	4206	"	-	-
85500-85800	O	22/150	447	CAST. SUF	"	CARD.G20	24	-	6/8-D 17 1/2	"		AJX-V	"	ENT	PRIS DUMP	22	B-76	13]	6	ROYAL INT C	350-1 5	B&C	F76		2	-	-
89000-89749	"	"	402	P.S. '23	"	"	"	-	"	"		MIN LEVER	"	P.S.	DUMP	15	7118	PS	6	"	"	F78 BETT			"	-	-

Fig. 1—A sample double page of the pocket-size reference book which gives condensed data on system car series with detailed identification references to the various items indicated by the headings

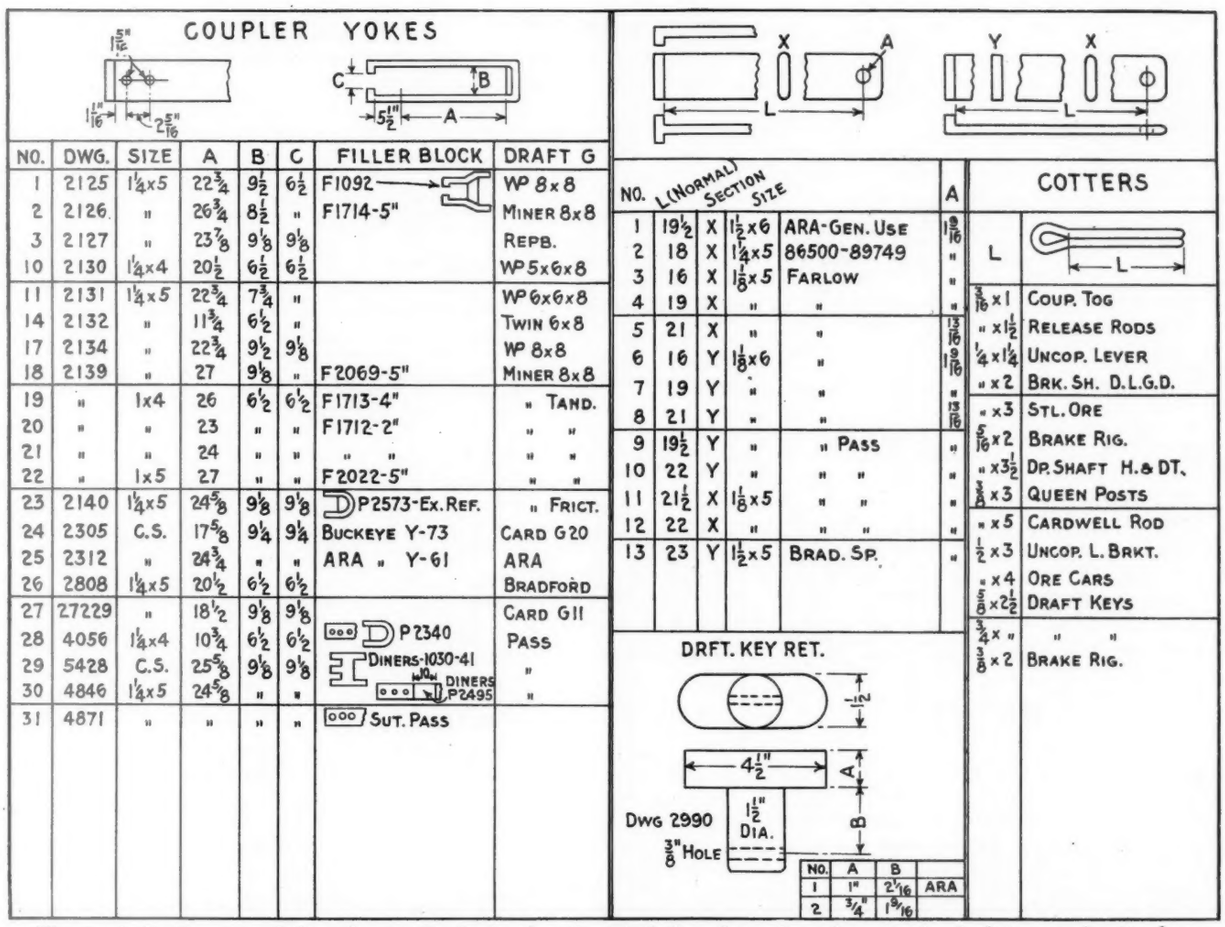

COUPLER YOKES
NO. DWG. SIZE A B C FILLER BLOCK DRAFT G
1 2125 1¼x5 22¾ 9½ 6½ F1092 WP 8x8
2 2126 " 26¾ 8½ " F1714-5" MINER 8x8
3 2127 " 23⅞ 9⅛ 9⅛ REPB.
10 2130 1¼x4 20½ 6½ 6½ WP 5x6x8
11 2131 1¼x5 22¾ 7¾ " WP 6x6x8
14 2132 " 11¾ 6½ " TWIN 6x8
17 2134 " 22¾ 9½ 9⅛ WP 8x8
18 2139 " 27 9⅛ " F2069-5" MINER 8x8
19 " 1x4 26 6½ 6½ F1713-4" " TAND.
20 " " 23 " " F1712-2" " "
21 " " 24 " " " " " "
22 " 1x5 27 " " F2022-5" " "
23 2140 1¼x5 24⅝ 9⅛ 9⅛ P2573-Ex.Ref. " FRICT.
24 2305 C.S. 17⅝ 9¼ 9¼ BUCKEYE Y-73 CARD G20
25 2312 " 24¾ " " ARA " Y-61 ARA
26 2808 1¼x5 20½ 6½ 6½ BRADFORD
27 27229 " 18½ 9⅛ 9⅛ CARD G11
28 4056 1¼x4 10¾ 6½ 6½ P2340 PASS
29 5428 C.S. 25⅝ 9⅛ 9⅛ DINERS-1030-41 "
30 4846 1¼x5 24⅝ " " DINERS P2495 "
31 4871 " " " " SUT. PASS
NO. L (NORMAL) SECTION SIZE A
1 19½ X 1½x6 ARA-GEN. USE 1 9/16
2 18 X 1¼x5 86500-89749 "
3 16 X 1⅛x5 FARLOW "
4 19 X " " "
5 21 X " " 1 13/16
6 16 Y 1⅛x6 " 1 9/16
7 19 Y " " "
8 21 Y " " 1 13/16
9 19½ Y " " PASS "
10 22 Y " " " "
11 21½ X 1⅛x5 " " "
12 22 X " " " "
13 23 Y 1½x5 BRAD. SP. "
DRFT. KEY RET.
4½"
DWG 2990
1½" DIA.
⅜" HOLE
NO. A B
1 1" 2 1/16 ARA
2 ¾" 1 9/16
COTTERS
L
⅜x1 COUP. TOG
" x1½ RELEASE RODS
¼x1¼ UNCOP. LEVER
" x2 BRK. SH. D.L.G.D.
" x3 STL. ORE
5/16x2 BRAKE RIG.
" x3½ DR. SHAFT H. & DT.
⅜x3 QUEEN POSTS
" x5 CARDWELL ROD
½x3 UNCOP. L. BRKT.
" x4 ORE CARS
⅝x2½ DRAFT KEYS
¾x " " "
⅜x2 BRAKE RIG.

Fig. 2—A double page of the reference book showing the tabulation of coupler yokes, coupler draft keys and cotter keys

similar part, used on home cars, is available for quick reference, a home standard can often be found that will fit properly. When this can be done the excessive cost of hand manufacture is obviated, a general saving on the job is effected, and the movement of the car is expedited.

In order to surmount these difficulties by providing readily accessible detail information, the general foreman of a large western car repair shop compiled a condensed tabulation of system car series, showing thereon identification numbers for the repair parts most frequently called for. This was made up in a pocket-size, blue-printed booklet, and issued to foremen, sub-foremen, inspectors, material men, store men, and to any others to whom the information would be helpful. The plan worked out so well that later the amount of information included was materially increased and the books were sent to all car-repair points and issued to the various employees to whom the contained information would be useful.

This book has also proved to be of considerable value to higher railroad officers. The book now contains 36 pages, 10 of which cover car series, the balance being tabulated details.

For convenience in connection with a data book of this kind, as well as for other record purposes, the various fabricated parts are given individual numbers which are shown on detail drawings of those parts. Sample pages from this book, which is 4 in. by 6 in. in size, are shown by the drawings.

Fig. 1 shows a sample double page which covers the data on a system house-car series with detailed identification references to the various items indicated by the headings. This page is made up from groups of series taken from several pages of the book. The car series are arranged in numerical sequence with the series divisions made on mechanical construction lines. Following the series is a symbol to indicate the kind of cars, after which is given the nominal length and capacity, the average weight, and the builder and date built; all this information being of a general and useful character. Following these come detail references, which are, as far as possible, grouped according to the relation to each other, such as draft gears, coupler yokes, draft-gear followers, couplers and draft springs. Truck details shown are also grouped, all making for quick and convenient reference.

Double-ruled, vertical lines are used to divide the groupings and to serve as a guide to the eye in following the items down the columns. A light, horizontal guide line to each few items is used, it being less confusing than a line for each item, or no ruling at all. Ditto marks are purposely used as they indicate more clearly to the eye the fact that the items are alike than would be the case with a repetition of figures or symbols. This method also has an educational value in that such similarities stand out more prominently, and therefore will be more readily memorized and, since a thorough knowledge of details is essential, it leads to a higher degree of efficiency. With the same end in mind, like detail dimensions of similar parts shown on tabulation pages are also dittoed.

While the headings illustrated in Fig. 1 are those pertaining to the class of cars shown thereon, appropriate

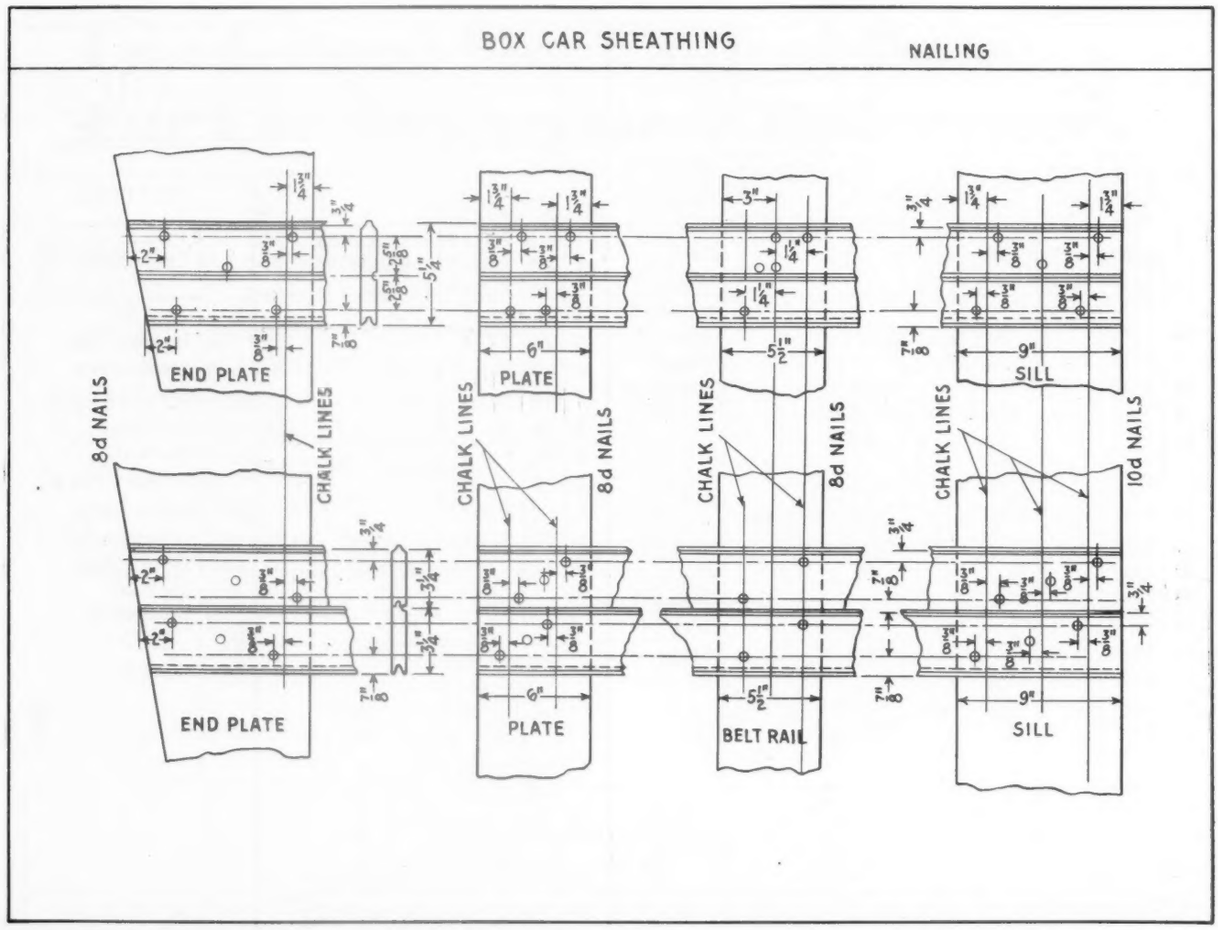


Fig. 3—A page from the book which shows in detail the method for nailing side sheathing on box cars

headings are used on other pages covering other types of cars to include as many details of the cars as possible. Vacant lines are left on different pages where a large block of vacant numbers between car series occurs, so that when such vacant series are filled out, they may be entered at the proper place in the book to maintain the scheme of keeping the book orderly and the series in numerical sequence.

Other pages in the book tabulate in a similar manner the various parts of special cars, such as cabooses, tank cars, dump cars and other types of work equipment. Only those occurring in appreciable groups are shown, as the inclusion of all work cars would make a too cumbersome record for the purpose for which the book is primarily intended.

Tabulation of Coupler Equipment

Fig. 2 shows a tabulation of coupler yokes, coupler draft keys, and cotter keys. The sketch at the top shows the location and size of coupler-yoke rivet holes, while in the tabulation all the essential identification dimensions are given with a symbol indication as to the kind of draft gear with which each is used. Dimension *A*, it will be noted, is the draft-gear opening in the yoke. That dimension and the width of the opening are the most commonly used identification dimensions, but with the details indicated by the sketch, any other identification may be quickly and accurately made.

Coupler draft-key dimensions are shown similarly, the table including A.R.A. standard, Farlow, and other special sizes, with tabulated dimensions and symbols to indicate rounded or flat edges. The tabulation of cotter keys is included as a guide to proper sizes for those in most general use and as an aid to standardization.

Another page in the book tabulates information concerning arch bars. At the top of this page is a sketch, the dimensions on which are represented by various letters. The dimensions of various sizes of arch bars, for which the letters stand, are then given in the tabulation. The bar numbers are grouped in sets by light horizontal lines. A mechanic with a general knowledge of arch-bar construction could fabricate, in an emergency, an arch bar from the ruling dimensions given on this page. In case an arch bar is required for a foreign car, by taking ruling dimensions, it can be ascertained, by reference to the tabulated material, if there is a system bar that will fit. This is a frequent occurrence and in many instances much time and considerable money can be saved. This is obvious, since the home arch bar is machine-made on a quantity production basis, whereas an individual bar would be hand-made. Having the proper bar at hand to facilitate repairs may also result in saving a day's service to the car.

Tabulation of brake-beam hangers, included on another page, shows all the brake-beam hangers used on the system in full detail. They are numbered according to the various styles used on the road and opposite each number is shown the style of brake beam, its length, the size of the pin hole and the size of the shank.

Another page in the book is illustrated in Fig. 3, which shows the detail method for nailing side sheathing on box cars. This shows the proper location for each nail, as well as the size of the nail and the number to be used in each location. Naturally, the actual nail loca-

tion is approximate, but this sketch gives a general outline for guidance in doing this work.

A diagram similar to the one shown in Fig. 3 is used on another page to show the proper method to be used for nailing car decking. For further convenience of the mechanics large prints of these nailing pages are framed and posted at different points in the shop.

Tabulation of Truck Side Frames and Bolsters

A full page is included in the book which shows the car series, in numerical order, which are equipped with cast-steel truck side frames, or cast-steel truck bolsters. This page shows the builder's numbers cast on these parts, the nominal capacity of car, and the section and type of side frame used. On the opposite page are grouped interchangeable cast-steel truck bolsters and truck side frames which, while carrying different builder's numbers are of like construction. This information is of importance to both the mechanical department in making replacements and to the stores department in keeping down stock by eliminating duplications.

Brake levers are also tabulated in the book, the tabulation consisting of car series arranged in numerical sequence, with headings for the different levers, and a sub-head showing lever numbers and hole spacings. The numbers for the levers which are tabulated are those used for the same lever on detailed drawings. As added information, the size of brake cylinders is shown in the last column on this page. These sheets are not generally included in the data book, being issued only to those requiring them in connection with their assigned duties.

Numbers are extensively used for various detail items. Such a system is of general convenience in that it simplifies stock records and facilitates reference study by mechanical-department men. Therefore, in making drawings of details of which several kinds are used—brake beam hangers, for example—it is the practice, when feasible, to group these on a general drawing, giving each an identification number. This system has been of particular advantage in the preparation of this book.

The general use of the book has not only served to help standardize and expedite repair work, but has had an inestimable educational value. Its convenience and ready accessibility are inducements for its study and, as a consequence, those responsible for shop production, as well as inspectors, mechanics, and others, have learned a great deal regarding car series and car construction.

Draft springs are also tabulated in the book, the number and size being shown in headings with the number of springs per draft gear shown in appropriate columns opposite side items indicating draft gears. For further convenience, draft follower-plate and coupler-yoke numbers are shown on this page. Truck springs are likewise tabulated, and a set of small diagrams is included, indicating groupings of the A.R.A. truck spring.

Facilitating Repairs on Cars Set Out

The data contained in this book are of especial value in case it becomes necessary to send men out on the line to make emergency repairs to a system car which has been set out. Given the car number and defect, correct information may be gained at once by referring to data book, and proper material taken along by men for making repairs. Since correct material is at hand, such repairs are of a permanent character, instead of a makeshift, temporary arrangement to get the car to the next repair point. Thus the movement of the car has been greatly expedited, the cost of repairs has been held down to a minimum, and the accident with its attendant added cost for rip-tracking the car for proper repairs is obviated.

A similar data book of the same size as that covering freight cars has been prepared for passenger cars. In this instance the individual car numbers are shown in numerical order and for convenience the car number is shown at the front of first page, as well as at the back of the opposite page. Each book referring to freight- and passenger-car data is furnished with pages which give the key to the symbols and abbreviations that are used on the various pages.

* * *

M-K-T auxiliary tender for eliminating water stops—The tank is made of 5/16-in. and 3/8-in. copper-bearing steel plate, is set on a Commonwealth cast-steel underframe and has a light weight of 84,000 lb.—It is equipped with independent brake cylinders on each truck, a running board, two man holes, a tank hose connection to the tender tank or direct to the right hand injector and has a 15,550 gal. capacity—The car illustrated is one of five now in service

A Fight For Your Jobs

THE proposals of the railroad executives for effecting a more equitable status of regulation as between themselves and competing forms of transportation have led spokesmen of the automotive industry to assume that the entire industry is under attack. In public statements they are trying to make it appear that the position of the railroads with respect to competition which they are meeting from motor vehicles operated "for hire or profit using the highways" is against the interests of the private automobile owner, operators of buses within as well as between cities, owners of trucks who operate them privately in the conduct of their business, and commercial truck operators whose business is strictly intra-city, as well as those who operate on inter-city routes. They are in particularly violent opposition to the railroads' proposal that there should be "adequate provision for privilege or license fee imposed on all motor vehicles for hire or profit, using highways so as properly to participate in construction and maintenance costs of highways."

In round numbers some twenty-six million motor vehicles are registered in the United States. Of this total, about 3,240,000 (1929 registration) are motor trucks, over 2,900,000 of which are rated at two tons or less carrying capacity. Few, if any, of these small trucks are operated on highways for hire or profit. Trucks so operated are confined to some part of the 250,000 vehicles, ranging from two and one-half to over five tons in capacity. There are some 92,500 buses, of which only about 24,000 are in common-carrier service on the highways.

Assuming that all of the higher capacity trucks are in service on the highways "for hire or profit," there are 94 other motor vehicles for each bus or truck operating as a common carrier or for hire over the highways.

The highways over which these common-carrier or for-hire vehicles operate are, in the aggregate, provided largely by the special taxes paid by the owners and operators of automobiles, buses and trucks who either do not operate for profit or hire or whose operations are confined to city streets. The cost of construction of these highways, however, to meet the requirements of these relatively few but heavy commercial vehicles is several times greater than would be required if their use were confined to the lighter vehicles operated by private owners. This is indicated by the fact that in 1929 the average expenditure for construction of state highways was over $17,000 per mile of highway built during that year, whereas the average expenditure for local roads amounted to less than $6,000 per mile of local road built during that year. The expenditure for maintenance of state highways per mile in service at the end of the year was $550, while the expenditure per mile of local highway was $95.

The owner of a private automobile who uses his car on city streets for six days a week with an occasional Sunday trip over the state highways, as well as the owners of trucks and buses operated exclusively over city streets, is contributing heavily for the construction and maintenance of the expensive state highways financed by the revenue from license fees and gasoline taxes. Many of these highways have been built at a cost per mile comparable with that required to build and equip a steam railroad in order to meet the requirements of about one per cent of all motor vehicles in operation. The farmer who operates his truck over the local highways built and maintained from county revenues pays for these highways largely in his general property tax at the same time that he contributes to the construction of the expensive state highways by his gasoline and license taxes.

In asking that motor vehicles operating "for hire or for profit using the highways" be required to participate properly in the construction and maintenance costs of the highways, the railroads are certainly acting in the interests of the vast majority of motor vehicle owners.

Commercial motor vehicle operators in their attacks upon the railroads' program for adequate regulation of highway competition claim that the railroads are attempting to penalize a cheaper form of transportation. It is for an economically sound co-ordination of highway and rail services that the railroads are working. Such a co-ordination can only be effected when both forms of transportation are so regulated that the entire cost of the service to the shipper shall be included in the rate which the shipper pays. So long as the railroad rate includes the entire cost of the service, while the rates charged by operators of buses and trucks over the highways include only part of the cost of the service, the rest of which is contributed by private operators of motor vehicles and other taxpayers, an economic co-ordination in the interests of the public is impossible.

Help make these facts clear in your community.

EDITORIALS

Scale Your Sand Boxes

Sandpipes stopped up with scale and lumps of sand are evils which have been with the railroads for many years but are still problems which concern engine crews and enginehouse forces. The sandbox should not be neglected when a locomotive is on the drop pit or in the shop for class repairs. Scale can be prevented from getting into the sandpipes if the sand is removed at such times and the box is scaled on the inside by lightly hammering it so that all the loose scale can be removed. Careful inspection of the sandbox and ascertaining whether or not the sanders function properly will go a long way toward reducing the number of delays on the road.

Is the Use of Free Oil Economical?

Appearing elsewhere in this issue is an article by a chief-car inspector in which he condemns the wholesale use of free oil as practiced by a number of roads in lubricating car journals when passing over humps and through dispatchment yards. This article was prepared at the request of the editor in response to inquiries from a number of readers of the *Railway Mechanical Engineer*. There is no question but that there is considerable waste of oil when the lubricant is poured into the journal box while the car is in motion over a hump. Oil on the end of the journal, on the sides of the box or seeping out of the back of the box is not doing its job. Packing should be re-adjusted in the box after new oil has been added. Still, the big job is to get the cars over the road. Sometimes theoretical ideas have to be modified to meet the demands of actual practice. The question to be answered is: Do the results justify the waste of free oil? We would like to hear from others on this subject.

Economy in Sand-Blasting

A notable and desirable increase in the amount of sand-blasting done on both locomotive and car equipment has taken place within the last few years, resulting in numerous economies and advantages to the railroads. Principal among these may be mentioned the saving in labor, as sand-blasting provides one of the easiest and most rapid means of cleaning metal surfaces. Moreover, the sand blast does a thorough job of cutting away dirt and paint, particularly in corners and irregular places where manual methods would be ineffective unless carried out with the most painstaking care.

Many railroad sand-blasting operations are carried on out of doors, although sand blast sheds are being provided to an increasing extent to permit carrying on the work under all weather conditions. The equipment needed is simple and relatively inexpensive to install, comprising primarily a sand storage bin, vibrator or cleaner, dryer, air and sand mixing tank, syphon connection to the shop air line, rubber hose lines and nozzle pipes. Among the locomotive parts most commonly sand-blasted are cylinders, frames, boilers (inside and out), and motion-work parts, the purpose being to remove rust and scale and permit a thorough inspection for defective material and cracks. Jackets are also sand-blasted at some shops, as well as the exteriors of locomotive tanks, to secure a smooth, scale-free surface, preparatory to repainting and varnishing. Steel passenger cars are sand-blasted for the same purpose, and a limited number of railroads are sand-blasting steel freight cars with good results. The idea that any kind of work, including careless painting, is good enough for a freight car is altogether too prevalent, and, since corrosion is admittedly the greatest enemy of steel equipment of all kinds, the relatively small additional expenditure for sand-blasting steel freight cars, in order that a protective coating of durable paint can be applied directly to the original metal instead of over a layer of rust or mill scale, may well prove a wise investment.

A good quality of cutting sand is required for the most efficient operation in sand-blasting, but experience has shown that this can be worked back into the sanding system and re-used several times before the cutting qualities are lost. The cost, from this point of view, therefore, is minimized. Three months' life, or more, may be expected from good rubber hose used in sand-blasting service, so that this item of expense is not prohibitive, considering the benefits derived. Pipe nozzles cut out much more rapidly, often lasting only a few hours, but they are usually made of short sections of scrap ½-in. pipe and, therefore, cost little. The indications are that a still more extensive use of sand-blasting operations at many railroad shops would prove worth while from the point of view of economy and better workmanship.

Faster Speeds in Railroad Service

The idea of travelling at a speed of 100 miles an hour invariably stimulates the imagination. We think of airplanes and racing automobiles along Daytona Beach. Writers of fiction and hair-breadth-escape stories frequently picture the hero as dashing away at 100 miles an hour with the beautiful damsel in his monoplane or sport-model roadster to be married and live happily ever after. If the setting of the romance requires escape on a locomotive with the hero at the throttle, we usually read that the engine was swinging around the curves at the terrific speed of 60 miles an hour.

The railroads have made as much progress with respect to speed as have other forms of transportation. Only they have not done so much bragging about it. The "Flying Scotsman" on the London & North Eastern in England must reach 100 miles an hour during certain parts of its run to maintain its schedule. This is not a new development but a passenger-train operation which has been in effect for several years.

Progress with respect to locomotive speeds has also been making considerable headway on this continent. Published elsewhere in this issue, is a report on the performance of the Canadian Pacific 4-6-4 type locomotives which frequently operate at average speeds of from 90 to 95 miles an hour. These locomotives are capable of

being operated at and undoubtedly do reach considerably higher speeds. There are several railroads on this continent on which passenger trains operating over extended runs have attained speeds of 120 miles an hour.

The attainment of such speeds must not only be credited to the designers and builders of locomotives but also to the engineers who are responsible for the development and maintenance of road bed, track and signals. That such speeds may be hazardous to the travelling public is largely a psychological phenomenon. The technical problems of safety and comfortable riding are practically solved.

White Elephants In the Railway Shop

Modern production methods employed in highly specialized industries are applicable to a certain degree in railway shops of roads using modern power and rolling stock. The degree to which the methods can be employed depend upon the size of the shop and the demand for the continuous repetition of one or more jobs in exactly the same manner. Shop schedules for locomotives and cars have been carefully scrutinized and have been reduced to a point where a large percentage of the slack has been removed from the human side of the problem. This is especially true during the present critical condition facing the railroads which are now operating trains and maintaining equipment with a greatly reduced personnel.

The problem of reducing shop schedules and speeding maintenance operation can be alleviated by the installation of modern shop machinery and equipment. Many railroads have adopted a conservative policy towards the use of specialized equipment and machines for grinding bearings, crank pins and bushings and automatic lathes for turning tapered frame bolts, portable machines for facing pedestal-jaw faces and similar machines. The adoption of modern equipment for re-conditioning locomotive and car parts not only facilitates the speeding up of repairs, but also increases the life of the repaired equipment after it has been replaced in service. Longer service life of locomotives and cars is being assured by many machine tool builders who have brought out equipment for producing highly accurate work.

With the present day demand for speed in the railway shop the fact remains that production must be increased without increasing the production per man-hour. There remains the one factor of reducing machine time for repairing the various locomotive parts and appurtenances.

The continued use of machines and equipment which are costly to maintain and which are not capable of producing in proportion to their maintenance cost, increases shop costs and hampers the output of other machines directly in the production line. They have been pertinently characterized as "white elephants."

White elephants in the railroad shop are familiar to all who are acquainted with railroad shop production methods. They have champions in the railroad shop who maintain that what little work is completed on such machines warrants their continued use, maintaining further that a new machine bought to eliminate the old one would probably be idle a portion of the time. Little thought is given to the fact that white elephants can only be used for the less precise classes of work which could better be done on new equipment that would increase its service life. And while the obsolete tool can only be used for a very limited classification of work, the new equipment can be utilized for all of the classes of work completed on the old machine, and also for others which will keep it in continuous operation.

The existence of white elephants is indisputable, but they are not always easily distinquished. Search for them and eliminate them.

Car Men Help Reduce Transfers

A notable reduction has been achieved by the railways generally in the number of transfers of loaded cars, received in interchange but unfitted to move to destination because of improper loading or serious defects in the cars, themselves. The average cost of transferring a load of freight from one car to another is estimated to be approximately $25 a car, exclusive of damage claims. When it is considered that only a few years ago the cars transferred annually at almost any of the major interchange points were numbered in the thousands, the economy and savings represented by present-day performance are striking.

Take, for example, the almost phenomenal reduction in transfers of cars passing through the Chicago district. Records of the Chicago Car Interchange Bureau, as shown in the brief accompanying summary table, indicate that the number of transferred cars was reduced from 11,938, in 1924, to 805, in 1930. This was a total reduction of 93.2 per cent in a period of seven years. The most marked reduction in any one year occurred in 1926, when 57.8 per cent fewer cars were transferred than in 1925. In many respects, however, the reduction of 37.6 per cent, in 1930, over 1929, represented an even more striking performance, since the number of cars transferred in 1929 had already been reduced to what many considered a minimum figure. On the basis of $25 transfer cost per car, the approximate saving, represented by the 1930 performance at Chicago as compared to that of 1924, was $278,325.

It may be said that fewer cars were interchanged during 1930 than in the previous year and that this automatically assisted in making a good showing as regards cars transferred. It is true that the cars interchanged at the Chicago district in 1930, as compared to 1929, were reduced probably about 13.4 per cent, or the same as the reduction in revenue car loading throughout the country at large, but the reduction in cars transferred was 37.6 per cent.

Seven-Year Record of Car Transfers at Chicago

Year	Number of cars transferred	Percentage reduction over previous year	Approximate total cost of transfers*	Approximate saving compared with 1924
1924	11,938	...	$298,450	.....
1925	7,253	39.2	181,325	$117,125
1926	3,047	57.8	76,175	222,275
1927	1,775	41.8	44,370	254,080
1928	1,421	19.9	35,525	262,925
1929	1,289	9.3	32,225	266,225
1930	805	37.6	20,125	278,325

* Assuming an average cost of $25 per car, exclusive of claims.

The reduction in transfers at Chicago and other interchange points represents a greater accomplishment than indicated by the figures because car conditions are far from being entirely satisfactory. Deferred maintenance and the failure, in many cases, to select suitable cars for loading, due to no small extent to the drastic and forced reduction of inspection crews, have resulted in many unfit cars passing to shippers for loading. There is some evidence that, too often, trunk line carriers are not doing all that they can to prevent the delivery of these loaded bad order cars to connecting lines and, while this pertains to railroad-owned cars, it is particularly notice-

able in the case of privately owned cars, accepted for movement by the carriers in spite of the fact that they are not in the necessary physical condition to meet the requirements of modern high-speed operation. These cars are, no doubt, accepted for movement under the threat of traffic diversion, and the most effective remedy is the concerted action of the carriers to reject such cars, a result more easily talked about than achieved under present highly-competitive conditions.

That the number of cars requiring transfer would be greatly increased, except for the ingenious, earnest and strenuous efforts of car department supervisors to make repairs under load, cannot be doubted, and efforts along this line should be redoubled. It is also the duty of car supervisors to miss no opportunity to show their superior officers the false economy of excessively reducing car inspection and light-repair forces and then paying out what has been saved for transfers, with all that they mean in the way of train delay, operating expense and damage claims, not to mention dissatisfied shippers.

The Chill-Worn Wheel Defect

The only remaining judgment wheel defect with which the car inspector has to contend is the worn-through chill. If the wheel wears through the chilled metal of the tread it is a manufacturer's defect provided it occurs during the life of the guarantee. However, many inspectors place themselves in a position open to criticism by condemning wheels for chill-worn spots which in reality are slid-flat spots and, therefore, not owner's responsibility. In the latter instance the age of the wheel will occasionally indicate that it is not worn through the chilled metal.

Although the mottled grey-iron appearance of the worn-through portion of the tread indicates a chill-worn wheel, it does not always certify that the defect exists. A flat spot or depression is one indication used by inspectors in condemning this wheel, while another is to attempt to chip the worn-through spot with a cold chisel. The chill-worn wheel has some of the characteristics of a slid-flat wheel, especially in the fact that it sounds like one as it passes over the rail. Many inspectors, hearing the wheel bumping over the rail, will note the car and look for a slid-flat wheel when inspecting it.

The chill-worn wheel is characterized by an out-of-round condition which sets up excessive vibration in the truck, which results in the loosening of the truck parts. The continued vibration of the truck after these parts become loose will cause them to wear excessively until they become bright or shiney. This is true of column bolts, tie-strap rivets, journal box lids and, in the case of a one-piece side frame, the brake-hanger bolt holes and the spring-plank and truck-spring seats. The worn condition of these parts, when detected by the inspector should receive his closest scrutiny for the cause which in many instances will be the chill-worn wheel.

This defect, if not promptly discovered and remedied, will flatten rapidly and will often result in the breaking of the wheel rim, causing a derailment. Being a judgment defect, everyone concerned with the handling of wheels should make a careful study of it, the conditions under which it occurs, and its detection. Any systematic educational program for car inspectors should provide complete information to enable him to detect chill-worn wheels and to distinguish between those which are chill-worn and those which just appear to have this defect.

NEW BOOKS

ESSAYS OF A LOCOMOTIVE MAN. *By E. A. Phillipson. Stiff board binding, 5½ in. by 9 in., 143 pages, illustrated. Published by the Locomotive Publishing Company, 3, Amen Corner, E. C. 4, London, England.*

The book is comprised of 35 short essays of locomotive design, operation, and maintenance, each essay being a chapter. Subjects discussed include: Lubrication; Boiler Feeding and Superheating; Standardization; Steam Distribution; The Rivals of the Steam Locomotive; Shunting Methods and Costs, and Periodic Examinations.

VIEWS AND REVIEWS OF THE HOT-BOX SITUATION. *By J. C. Stewart, Car Inspector, 123 North Belmont, Indianapolis, Ind. Cardboard binding, 4½ in. by 6 in., 65 pages. Published by Trade Educational Bureau, Brotherhood of Railway Carmen, 2275 South Lincoln Avenue, Denver, Colo. Price 50 cents.*

A small informative book which deals with the hot-box situation. In it are advanced the reasons for hot boxes and suggested remedies. The author has dealt with the subject in the language and style of the car man, treating every phase from the preparation of the packing to the finished packed journal. The book contains illustrations ranging from journal boxes, tools, etc., to apparatus used in reclamation plants.

SECOND WORLD POWER CONFERENCE, BERLIN 1930. *Bound in cloth, 6½ in. by 9½ in., 264 pages, non-illustrated. Published by VDI-Verlag G.M.B.H., Berlin, NW 7, Germany.*

This volume is one of a set of publications reporting the technical sessions of the Second World Power Conference which was held in Berlin, June 16-25, 1930, inclusive. It contains brief abstracts of all the papers which were presented during the conference which are arranged under 34 different heads. Some of these group heads are as follows: Construction and Operation of Large Power Plants, which section contains nine papers; a section on Steam Turbines, Gas Turbines and Reciprocating Steam Engines, under which it grouped a total of 13 papers; and a section entitled "Stationary Internal Combustion Engines and Research Work in this Connection," under which are grouped abstracts of 11 papers.

INDEX TO A.S.T.M. STANDARDS AND TENTATIVE STANDARDS. *Issued by the American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa. 114 pages, 6 in. by 9 in. Paper bound.*

This pamphlet constitutes a combined index to all A.S.T.M standards and tentative standards in effect as of September, 1930. The index is designed to be of service to those familiar with the society's standards in locating any specification or method of test in the bound publications in which it appears or to those interested in ascertaining if the society has issued any standards on a specific subject. It contains a complete list of the 427 standards and 155 tentative standards which appear in the 1930 A.S.T.M. Year Book and in both parts of the 1930 Book of Standards. A price list gives the prices of the bound publications in which the standards and tentative standards appear and the prices of standards in separate pamphlet form.

THE READER'S PAGE

Air Jammer Referred To Case No. 1666

To the Editor:

Again we have our old friend *Railway Mechanical Engineer,* March issue on hand, and as usual have read it from front cover to back. I have some criticism to offer on one subject; namely, "Dirty and Inoperative—Why?" on page 146 by "An Old-Time Air Jammer." Why does he want all the details on a repair bill when the word "Inoperative" is sufficient?

I want to refer him to Arbitration Case No. 1666 and to Interchange Rules 9 and 60; "Air brakes cleaned, within date account, inoperative—Unnecessary to specify why inoperative."

A Car Foreman.

Thirteen Thousand Dollars for Brooms

To the Editor:

In these days when everybody is trying to make the dollar go as far as possible, a person checks up all sources of expenditure—even brooms.

We have found that the ordinary household broom is a rather wasteful article as its life is very short and it is an inefficient tool. A good hair brush lasts considerably longer, does a better job, and a man can cover a considerably larger area in a given time.

Has any railroad or factory made a detailed study of what constitutes the best broom for factory or shop use? This is a comparatively small item, but the railroad with which the writer is connected spends about $13,000 for brooms in the course of one year.

An Economist.

On the Packing of Journal Boxes

To the Editor:

Does everyone follow the rule and pack journal boxes in strict adherence to the sketch shown on page 92 of the 1931 book of Interchange Rules? During the past year our road experienced considerable difficulty with the hot-box problem and discovered that a large percentage of them was caused by overpacking. We found that the packer was desirous of being on the safe side and overfilled the box, which, in our opinion, is one of the causes of waste grabs. I note from the records of an eastern railway club meeting that it is the opinion of one of its members that, if a box is packed with a good grade of wool yarn with long strands, the box fills up after the car has moved a very short distance with the result that the same condition of overpacking boxes is present. On the other hand, it is stated that if a grade of packing with short strands is used, this condition does not exist. I have been wondering to what extent this is true, not having encountered any condition similar to it.

In the same proceedings I note one member of the club advocates that when changing wheels, boxes or truck frames the old packing can be re-used if it is in a fair condition, provided the box has been packed recently. What of the grit and dirt which is liable to be in the bucket in which the packing is placed when pulled from the box? What of the dirt and cinders liable to accumulate on the top of the packing while the wheels are being changed, or the boxes or truck frames are being replaced, To use new packing, the road only loses the cost of renovating. It is peculiar indeed that any car department officer should advocate the re-use of old packing, especially after it has been allowed to stand in proximity to the rip track where it is liable to collect dirt, cinders and other gritty substances from innumerable sources.

Car Inspector.

Three Questions On A.R.A. Rule 66

To the Editor:

A foreign car on the handling road runs a hot journal. After an inspection is made the packing is found dry, or with insufficient oil properly to lubricate the journals. The car is in date according to the stenciling. Can joint evidence be secured, the boxes re-packed and the owner billed for the re-packing?

Can the receiving road reject a car for, "It being the inspectors conclusion there is not sufficient oil in the journal-box packing and car is liable to run hot journals with serious results," regardless of last date packed?

A car comes to its home road. The journal boxes have been re-packed by a foreign road within the past 60 days according to the stenciling on the car. The inspector inspects the car and makes out joint evidence "account dope does not meet the specifications," or "does not have sufficient oil in the dope." The car is moved to the owner's repair track and is re-packed and stenciled. A bill is made out against the road that re-packed the car last, using the joint evidence certificate. Can the owners collect?

A Subscriber.

A.R.A. Rule 17

To the Editor:

J. A. Garner asked a question relative to the application of 9⅛-in. butt couplers, which appeared in the February issue. The question was answered in March, but I should like to comment further on the subject.

There is no A.R.A. standard 8½-in. butt coupler and the application of a coupler with a 9⅛-in. butt is justified by paragraph *a* of Rule 17 which provides that A.R.A standard may be applied in place of non-standard material.

Why a 5-in. by 5-in. shank coupler with a 9⅛-in. butt and Type D head "does not meet these requirements," as stated in the answer in the March issue, is not quite clear. The shank size and the butt size are old-style A.R.A standards. The only objection possible seems to be in the fact that there is no standard Type D coupler with a 5-in. by 5-in. shank.

If this is the objection intended, I do not believe it would hold before the A.R.A. Committee. So far as I know, there is no restriction on the type of head under the old style specifications except that the head complies with standard contour, and it would seem to be permissible to use a Type D head on a 5-in by 5-in. shank.

Such a coupler would not be a Type D standard, but it would be a perfectly good job apparently as an old style coupler, and therefore a good repair in place of a non-standard 8½ in. butt coupler.

A. M. Orr.

Chill-Worn Cast-Iron Wheels

To the Editor:

As far back as railroad history is recorded, we know that the chilled-iron car wheel has had its place in railway service and, although there have been many improvements in it, there has been much discussion as to its true value. This is probably the result of the fact that it develops chill-worn spots which is one of the most important and the most overlooked defects. Car inspectors find cracked rims, seamy rims and treads, as well as worn and broken flanges, but they seldom find a chill-worn wheel. I am inclined to believe there are many car inspectors who do not understand what a chill-worn wheel is nor how to determine it.

We have all been standing near a passing freight train where we could hear the wheels pound. The usual impression is that the car in question has a flat wheel. This is the impression of most car inspectors who hear these pounds. When they inspect the train they expect to find a slid-flat wheel but as a rule they do not find it and conclude that the noise came from some other source.

A well-informed car inspector will look for that chill-worn spot and shop the car, because he knows if that wheel is permitted to remain in service it will eventually break and may cause an accident or at least a delay.

This defect is most serious and too much stress cannot be laid on its importance. When you see the box bolts loose and shiny around the top or bottom and the tie-strap rivets loose and shiny or, if on a one-piece side frame you note the brake-hanger bolt holes shiny and worn as well as the spring plank and truck-spring seat, you will know that they are conditions caused by excessive truck vibration. In the majority of cases this is caused by a chill-worn wheel.

The chill-worn spot is deceiving and requires a trained eye to detect it. It differs from a flat spot caused by sliding wheels in that it does not have sharp corners. Some chill-worn spots reach 6 in., 8 in. and 10 in. in length and sometimes longer. Many wheels will have more than one spot chill-worn.

After a wheel rim that is chill-worn breaks it is called a broken rim wheel, new defect. In some cases this is found too late, in other words after the derailment has occurred.

A chill-worn wheel is determined by observation and there is no gage to work by. The chill-worn spot has a mottled grey-iron dull appearance. On the outer edge of the rim it shows a wider rail wear while it shows a depth wear at the throat of the flange. The spot is usually not dead flat in appearance or measurement and is caused by the wearing away of the chill which leaves the weight to be carried on the iron in the wheel which is softer than the chilled metal and which wears away faster.

A definite way to tell a chill-worn wheel is to chip the chill-worn spot with an ordinary cold chisel. The spot will show a nick if the chill is worn. With ordinary tools you will not make an impression on the chilled part of the wheel.

General Car Foreman.

A Defense of "Dirty and Inoperative"

To the Editor:

The article in the March issue, under the heading—"Dirty and Inoperative—Why?"—by An Old Air Jammer, necessitates a comment.

First he asks why use the expression—"Dirty and Inoperative." Among the several reasons why this expression is used are the following: Some roads ship triple valves to and from the point of repair. There being no 3-T test rack at the point of repair and no visible defects on the brake equipment, the record writer has but one recourse and that is the evidence of the single-car tester, which shows the car to be inoperative on account of a defective triple. He has therefore been given authority by the A. R. A. to use the word inoperative. The latest decision by the arbitration committee is Case 1666, A. R. A. Circular No. D. V.-721.

The second important reason will be found in what "Air Jammer" has to say in his article concerning air-brake supervisors and A. R. A. checkers being continually on the job checking both the testing equipment and the operators. I agree with him that the 3-T test rack is a very sensitive and accurate mechanism, therefore, only in extreme cases of emergency should dirty triple valves be placed on them for test. At the present time we have no way of straining the air blown through the triple valve into the rack at the auxiliary tube. You can readily see that if you made a practice of running several dirty valves over your rack each day without cleaning your mechanism and valves, the rack would soon become unreliable.

Reference is made to 5-lb. rings, 7-lb. being the limit allowed. We will assume that we first clean the triple before putting it on the rack and when we test it we find that the ring is too close to the limit to permit it to go. Therefore the operator applies a new ring and shows the application on his triple-valve repair sheet. Then the record writer, if he follows "Air Jammer's" suggestion in following this triple to the repair room for specific defects, must naturally show why he made the record of "defective piston ring" which would be misleading and of no value in trying to improve conditions.

The present practice, I believe, is the most economical method of handling the situation as long as we have a blanket charge covering defective interior material in triple valves.

I enjoyed "Air Jammer's" article better than anything I have read in some time and hope to see other articles on this subject in print at some near future date as his points are well taken and are very interesting.

Tom DeMond.

With the

Car Foremen and Inspectors

Cleaning Cars With Live Steam

IN an effort to furnish shippers with cars which are not only thoroughly cleaned but completely disinfected and deodorized, the New York, Chicago & St. Louis has contracted with the Kenney Railway Maintenance Company to recondition box, automobile, refrigerator and stock cars at Toledo, Ohio. The car-cleaning plant at that point which has been in operation for several months utilizes steam and hot water for performing the cleaning operations without the aid of chemical solutions. Steam at 150-lb. pressure is used for drying the cars after the cleaning is done.

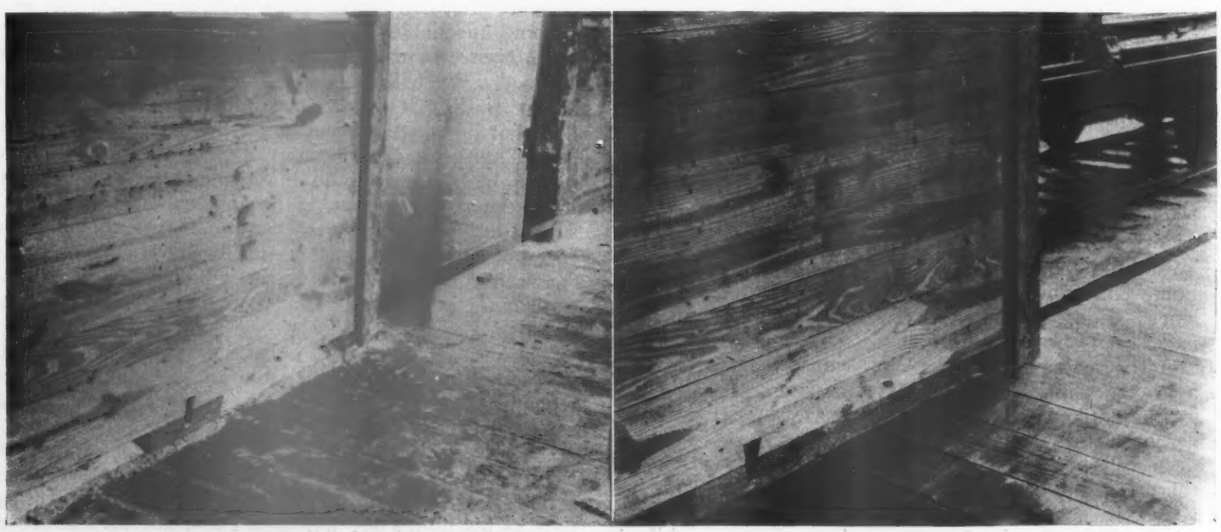
The cars as they arrive at the cleaning plant are found to represent a variety of conditions as far as interior cleanliness is concerned. The commodities or refuse therefrom which usually is primarily responsible for leaving a car in a condition unfit for immediate loading without cleaning are as follows:

Grease and oils (spilled)
Chemicals
Flour
Lime
Salt
Soda-ash
Fertilizer
Cement
Brick dust
Creosote
Clay
Paint
Hides
Sulphur
Manure (stock cars)
Vegetables
Sand
Charcoal
Fine ores
Terra cotta and tile
Refuse
Paste and glue for lining paper
Asphalt

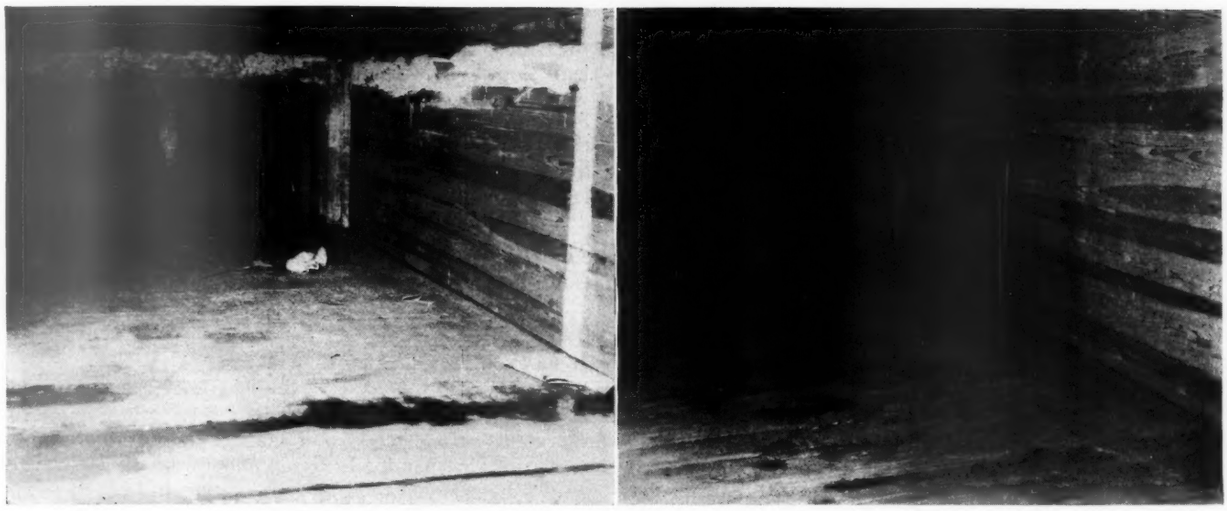
In the cleaning of house cars the interior of the car is first swept out and old nails and pieces of blocking removed. The car is then dampened over the entire interior surfaces with hot water to soften up the materials which it is desired to remove. The car is then washed with hot water and steam at 150-lb. pressure, the nozzle sizes varying from ⅛ in. to ½ in. to control the velocity of the jets, after which the car is thoroughly flushed out with cold water and finally dried with steam at 150-lb. pressure.

Stock cars quite often arrive at the cleaning plant during winter weather with the refuse (manure mixed with sand or straw) frozen. The same condition prevails with open-top equipment. The refuse is first thawed out with the steam jet, the car is washed with hot water and steam, rinsed with cold, clean water and finally dried out with steam.

Accompanying this article are several illustrations which show actual conditions in two types of cars before and after cleaning. In one case an automobile car arrived at the cleaning plant with the walls in an unsightly condition, as a result of pasting lining paper on them, and the floor was marked by numerous grease spots and spilled oil. The cleaning process removed all of the grease, oil and paste from the floor and walls and removed the paint over spots on the floor from which grease had previously been removed by the use of a torch. In the illustration of the automobile car after cleaning, these burned spots showed up plainly. Before the car is sent out again these burned spots are painted over. The other car shown in the illustrations is a box car in which a shipment of soda-ash had been loaded. When the car arrived at the cleaning plant, the refuse from the previous shipment of soda-ash was not only on the floor and wall surfaces of the car but was behind the inside lining as well. This is shown clearly in one of the photographs taken near a door of the car. In some respects, this car did not present as difficult a cleaning job as the automobile car except that more thorough flushing and washing were necessary. The other photograph in that group shows the condition of the car after being washed and flushed but before the final rinsing and steam drying. Cars of the type shown in the illustrations re-



Left: The condition of a box car after a shipment of soda-ash. A large quantity remains behind the inside lining—Right: After steam-cleaning and flushing. Note the cleanliness as evidenced by the clearly visible grain in the wood



Left: An automobile car with lining paper paste on the walls and grease and oil on the floor. Grease spots from previous shipments have been burned out and painted over.—Right: The same car after steam cleaning. Paste, grease, oil and paint are removed from the floor showing plainly the burned-over grease spots

quire about 40 min. on the average for complete cleaning.

There has been some criticism of the steam method of cleaning because under certain conditions the application of steam or hot water raises the grain on the wood and creates a rough floor. With the system described in this article the time required for the cleaning is so short that there has been no indication of any roughness in car floors as a result of the use of steam or hot water.

Wheel Inspection*

By D. M. Raymond†

ONE of the most important responsibilities of the mechanical departments of the railroads is that of wheel and axle inspection and maintenance, for which large sums of money are expended annually and which, when not properly done, often causes delays in both the mechanical and transportation departments. The proper inspection of wheels for wheel defects is one that cannot be given too much thought by supervisors. Some inspectors shop cars for wheel defects which, in a great many cases, are not condemnable. It is supervisor's responsibility to see that wheels are not removed until defects reach the condemning limit.

Slid-Flat and Shelled-Out Wheels

There should be no question on the slid-flat defect. Wheels should not be removed until they have a spot of 2½ in. or over in length, or two or more adjoining spots 2 in. or over in length on freight cars, and 1 in. in length on passenger cars. All of these spots should be dead flat. This defect is not dangerous in so far as the wheel is concerned, but it is liable to damage the rail and create extra rolling resistance. Neither should there be any question as to when a shelled-out wheel is condemnable as the rules state specifically that it shall not be removed from service until the spot has reached 2½ in. or over in length on freight cars and 1 in. in length on passenger cars. The shelled-out spot derives its name from the fact that it resembles an inverted oyster shell with a high center and it is generally believed to be a manufacturer's defect caused either by the inclusion of foreign material of some kind, or by seams underneath the surface metal, parallel to the tread of the wheel. It is not necessarily dangerous from the viewpoint of wheel safety, but has practically the same effect as a slid-flat spot. A seam in a cast-iron wheel is one of the most serious defects and, when located close to the flange, it is liable to cause the flange to break off. Any seam running circumferentially within 3¾ in. of the flange, measured at a point of ⅝ in. above the tread, is condemnable.

Worn-through Chill

This is the only judgment defect left in the Wheel and Axle Manual and, in the opinion of the writer, it causes more trouble and expense than any other wheel defect. It is the cause of a great many derailments because the worn-through chill wheel is out of round and, at high rates of speed, it will shake the truck to pieces. In a great many cases when brake rigging is changed and new arch-bars and new truck bolts are applied, wheels with worn-through chills are left in the car. There are a number of railroads which do this and, by paying little or no attention to wheels with worn-through chill spots, are thus repairing trucks without removing the cause of the damage. This defect is well defined in the Wheel and Axle Manual and explains how it should be condemned. However, it does not explain how the defect should be detected. In most cases, an inspector familiar with this defect can detect it by the condition of the truck, which is generally shaken to such an extent that bolts, pins, brake shoes and oil-box lids are polished in various places by vibration. When a condition of this kind is found it warrants a close inspection of wheels and, if a wheel is worn through the chill and an out-of-round condition has developed, it should be condemned and removed. The rules specify that the wheels should not be removed until a flattened-out spot has developed. However, a worn-through chill never gets entirely flat, but rather gets out-of-round.

Worn and Thin Flanges

The only caution necessary in the case of worn

* Paper presented before the February meeting of the Omaha Car Foreman's Association.

† Mr. Raymond is general car foreman of the Union Pacific at Council Bluffs, Iowa.

flanges is to properly apply the gage. Wheels are often condemned for having a vertical flange that are not properly condemnable. In order to condemn a flange for being vertical, the flange must come in contact with the limit point of the gage and not merely have a flat surface to the limit height. In order to be sure it does come in contact, a good practice is to take a piece of writing paper and try it between the contact point of the gage and the flange because it is often difficult to see whether the points come in contact or not. If the point does not come in contact with the flange, it should not be condemned. This wheel is not dangerous unless it is below the condemning limit and then it may lead to the breakage of the flange.

The method of gaging a thin flange on cast-iron wheels is simple and there should be no misunderstanding in the proper condemning of this defect. If the gage is not properly applied, that is, if it is tipped or tilted, the wheel will not be properly condemned. For cast-iron wheels of less than 80,000-lb. capacity, or wrought-steel, steel-tired, or cast-steel wheels, the wheel is condemnable if the flange is less than $\frac{15}{16}$ in. thick; wheels of 80,000 capacity or over are condemnable if the flange is less than 1 in. thick.

Brake-Burned and Comby Spots

There should be no misunderstanding of the proper condemning of wheels for brake burn, as transverse cracks in the tread are condemnable if they extend into the throat of the flange, into the flange, or are 2¾ in. in length. Considerable difficulty is often encountered by inspectors in properly condemning wheels with comby spots which are the result of brake burn. A wheel with comby spots is gaged the same as a slid-flat wheel and is not dangerous unless the material has fallen out of the tread for a continuous length of 2½ in. or over, or from two adjoining spots 2 in. in length or over on freight cars and 1 in. or over on passenger cars.

The wheel with a tread worn hollow is easily distinguished and should not be condemned until it takes the tread-worn-hollow gage. Little trouble is experienced in educating inspectors how to gage tread-worn-hollow wheels properly. Usually, however, very few wheels can be found which will take tread-worn-hollow gage before they are condemnable for some other defect.

A burst hub is usually the result of excessive pressure when mounting, caused by an improper wheel fit, gouging, or by excessively hard metal in the hub. Cracked or broken flanges, plates or brackets are very dangerous, because wheels with these defects are liable to fail at any time. Cracks or breaks usually appear on the inside face of the wheel. Cracked plates or brackets are generally caused by excessive heat, dirt in the plates, thin plates, or hard plates, the latter resulting from improper annealing. The single-plate wheel has overcome this defect to a great extent, but inspectors should be made to realize that whenever they see any indications of sticking brakes, or red or burned brake shoes, they should give the wheels careful inspection for cracks in the flange, plate or bracket.

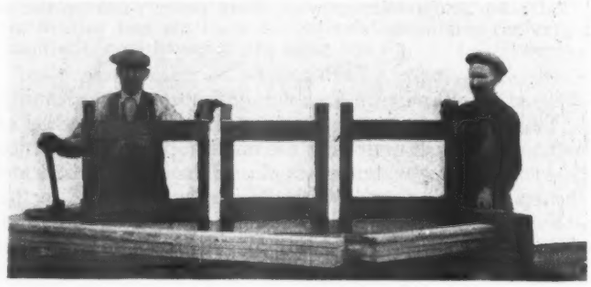
There should be no question as to proper condemning of chipped flanges as the rules state plainly that they should not be condemned unless they are more than ½ in. in width and 1½ in. in length.

Broken and Chipped Rim

Wheels are often condemned for broken or chipped rims where the metal is just flaked off in small areas. The wheel should not be condemned for this defect unless the rim is chipped off to the extent as shown in the rules, that is, where the fracture or break in the rim slopes outward. It is condemnable only if the width of the tread at the point of fracture is less than 3¾ in., (gaged at a point ⅝ in. above the tread) and the circumferential length of the fracture is 2½ in. or over. Where the fractures are reduced to 3½ in. or less, gaged at a point ⅝ in. above the tread, it is condemnable at any length, or where it is reduced to 3¾ in. and extends inwardly.

Lading Racks for Refrigerator Cars

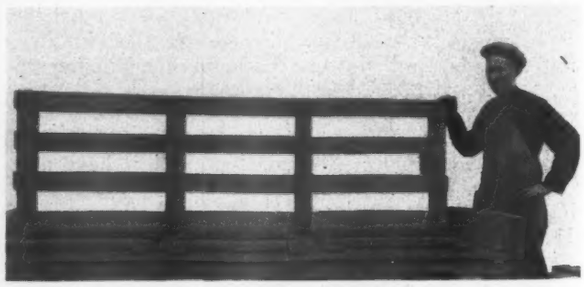
THE racks which are used in refrigerator cars for separating layers of various types of crated lading are made by hand. Large numbers of them are required by roads handling large shipments of this type



The three-piece jig used for separating the strips preparatory to nailing them

of lading, because they are often removed from the car when the lading is unloaded.

These racks are usually built of four 1-in. by 2½-in. boards tied together by four strips of the same size in the manner shown in one of the illustrations. When making these racks an eastern road uses a jig of three pieces, also shown in one of the illustrations, which is laid on a table with a sheet-iron top. The short cross-tie strips are placed between and at the ends of the three pieces of the jig, resting on the table top. The long strips are then laid perpendicular to the short strips, fitting in the pockets of the jig which are formed by blocks



The rack, completely nailed in 1½ min.

and strips nailed on the jig cross pieces. When the short and long strips are in place, the nails are driven and are turned when they strike the sheet-iron top of the table. The rack can be made by the use of this jig in 1½ min., this time including procuring the short and long strips and removing the rack from the jig when completed.

Repairing Coach Window Shades

THE coach repair department at the Miller Shops of the Florida East Coast, St. Augustine, Fla., has included in its facilities a bench, which is complete in practically every detail, for the repairing of window shades for passenger-train cars. The bench is of wood construction, built with the front legs extending up and connected with a cross piece at the top to form a frame,

Bench and rack for repairing window curtains in the Miller coach shops of the Florida East Coast

above the top of the bench, as shown in the illustration. Window-shade fixtures are mounted on a second bar, which is secured to the frame about 6 in. below the top. All shades are tested to see that the roller operates properly. If defective, repairs are made on the bench directly beneath. Repairs to shades, rollers, stops and all appurtenances are made on this bench.

Decisions of Arbitration Cases

(The Arbitration Committee of the A.R.A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Car Damaged In Unfair Usage

On February 4, 1929, M-K-T wooden box car 88181 was bad ordered by a Georgia inspector at Augusta, Ga., for loose truss rods. After being placed on a light repair track, shop inspection disclosed further defects which necessitated the removal of the car to the heavy repair track, but no written record of the additional defects were made.

While the car was being switched to the heavy repair track it was damaged as a result of misinterpreted signals. Before making repairs the Georgia had the car jointly inspected by representative of the Charleston & Western Carolina, the Georgia & Florida and the Georgia to determine which defects were the result of the damage sustained in the switching movement and which defects existed prior to that movement. A bill for the repairs of the defects existing before the switching movement was made was submitted to the M-K-T but was declined. The Georgia then amended the bill to include the cost of all repairs made.

The Georgia based its contention, that the amended bill as submitted was correct, on the fact that although the car was damaged under the conditions set forth in Section (d), Item 2 of Rule 32, the car was not damaged to the extent set forth in Rule 44.

The M-K-T contended that, since the handling line had no record of the defects existing on the car until the inspection was made after the car had been damaged under the conditions set forth in Item 2, Section (d) of Rule 32, the handling line was responsible for the damage. It also produced records which showed that the car had been repaired 12 days previously by the Atlantic Coast Line and which indicated that no defects other than those repaired by the A. C. L. existed on the car at the time the repairs were made by that road.

The decision as rendered by the Arbitration Committee follows: "In view of the unusual circumstances in this case, settlement should be made in accordance with Rules 32 and 41 on the basis of the joint inspection by the two disinterested inspectors."—*Case No. 1654—Georgia vs. Missouri-Kansas-Texas.*

Relightweighing Cars in Motion

During 1927 and 1928 the Western Maryland relightweighed a considerable number of Baltimore & Ohio cars for stenciling and billing in accordance with A.R.A. Interchange Rule 30. The cars were weighed while in motion with a rider, the speed being restricted to six miles an hour which allowed the car to be on the suspended-platform track scales a minimum of four seconds. The billing of 761 cars relightweighed during December, 1927 included 392 cars reweighed on account of variation in weight; 213 cars reweighted on account of being out of date and 156 cars reweighed on account of illegible markings. The B. & O. pointed out that the Western Maryland had no facilities for cleaning cars at Hagerstown, Md., the point where the cars were relightweighed. The B. & O. took 92 cars that were previously relightweighed by the Western Maryland and weighed them to determine any error in the Western Maryland figures. The cars were uncoupled and test weighed at rest. They showed variations between the Western Maryland old weight and the B. & O. new weight of from 20 lb. to 3,300 lb. Only 27 per cent of the test-weighed cars were within the 50 lb. limit prescribed by Rule 30, Section A, Paragraph 3. It contended that the Western Maryland violated Rule 30, Section F, Paragraph 9 of the Interchange Rules by weighing cars in motion and Paragraph 3 by weighing cars with the rider and not properly cleaning them before weighing. The B. & O. examined 2,722 cars at various points for illegible markings and stenciling and found that 2.33 per cent of these cars were marked or stenciled illegibly. The lightweight record of 451 of these cars, which were subsequently relightweighed by the Western Maryland was compared with the Western Maryland record of these cars, taken from their billing repair cards. This comparison showed discrepancies between the two records as follows: 53 per cent in old weight, 47 per cent in old

initial and 67 per cent in old date. The B. & O. contended that this indicated correct information was not furnished on the Western Maryland billing repair cards and claimed that it should cancel its charges.

The Arbitration Committee rendered the following decision: "In order to justify charge for properly relightweighing and remarking an empty car on basis of Rule 31, the car should be relightweighed at rest, uncoupled and free at both ends, as required in Paragraph (9), Section (f), Rule 30; it should also be clean and dry, within requirements of Paragraph (3) of the same section, and should conform to the other prescribed requirements of the rule.

"Settlement should be made accordingly; with the understanding however, that this decision is confined to the cars that were incorrectly remarked."—*Case No. 1656—Western Maryland vs. Baltimore & Ohio.*

Wholesale Use of Free Oil Condemned

By a Chief Car Inspector

A. R. A. Rule 66 was introduced primarily to minimize hot boxes and thereby improve freight- and passenger-train operation. That the objectives sought are being attained is manifest by the generally improved conditions of journal boxes and their contained parts. Today, journal lubrication is receiving closer attention than ever before, both as to the qualities of the lubricants used and the methods of treatment employed.

In addition to the periodic repacking and practices set forth in this rule, some roads have adopted a policy of using free oil, injecting it either by means of the oil can or the pneumatic system, in the boxes of cars before they pass over the hump or in despatchment yards prior to departure from terminals, on the theory that it further enhances lubrication of the journals.

The wisdom of such a policy has been the subject of considerable discussion. Some lubrication engineers contend it is helpful, while others claim it is wasteful.

The writer does not subscribe to the policy of free oiling in any such wholesale manner for the reason that it is both detrimental and wasteful and therefore should be discouraged as general practice. Where the practice prevails the application of free oil becomes mechanical; in other words, instructions are issued that all cars shall receive such treatment with the result that many a box gets a shot of oil whether it needs it or not and the writer ventures to say that the oil is more often deposited in the front than in the rear of the box. Of course it is well known that it is essentially important to carry the lubricant to the fillet end of the journal.

One evil from excessive oiling is that the packing becomes over-saturated and soggy thus impairing its resiliency. Furthermore, the presence of surplus oil frequently causes the waste to move out of position and when the packing iron is used the oil is forced out at the back of the box.

At best, free oiling is a hit-or-miss system. Oilers are seldom interested in knowing the quantity of oil necessary and usually it is injected without first adjusting the packing along side and back of the journal, hence the purpose of adding free oil is defeated.

Emergencies will occasionally arise when free oil is advantageous, for example in the cases of cars that have been stored or idle for a considerable length of time and as a consequence the oil has settled to the bottom of the box. In such circumstances the addition of a little free oil will temporarily lubricate the journal until normal running temperature is attained and capillarity reinduced, thus causing the waste again to feed oil to the journal.

In the last analysis the use of large quantities of free oil, with questionable results, is expensive. A practice that is less expensive but insures results is to adjust the packing to proper position against the journal and insert a piece of fresh packing against the rising side of the journal at terminals when the condition of the box indicates that such attention is necessary.

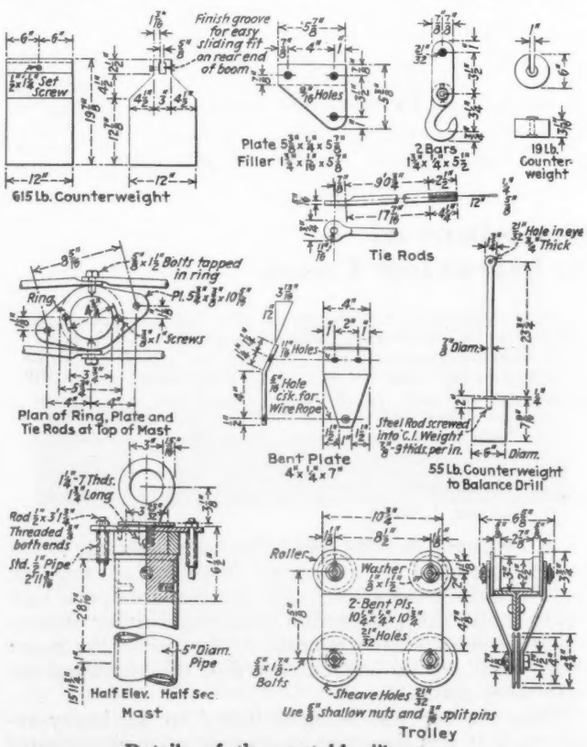
If railroads, however, will use satisfactory lubricants, both new and renovated, in the boxes of home as well as foreign cars and follow a program of periodic rejacking and repacking as outlined in Rule 66 any need for the use of free oil could be appreciably reduced and a considerable saving effected in car set-outs as well as in oil costs.

It would be interesting to get the views of those who advocate free oiling as they may have made some discoveries that would open up a new avenue of thought on this much mooted question.

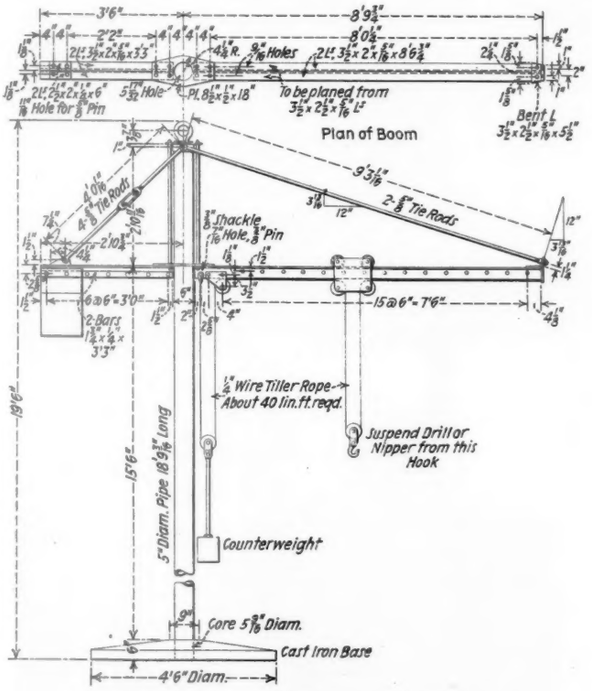
Portable Jib Crane For Power Tools

THE portable jib crane, the assembly and detail parts of which are shown in the two drawings, is used in the shops of a car manufacturer and also on several railroads in the east. This crane was designed primarily to lessen the labor of handling and operating air and electric tools along the side of a car or on the truck-repair track. Nippers, rivet busters, power drills and heavy hand tools of similar nature are suspended from the hook when in use. This method not only relieves fatigue, but frequently enables one man to perform work where ordinarily two are required.

The crane, as shown in the assembly drawing, is sup-


615 Lb. Counterweight
Plate 5⅜" x ¼" x 5⅜"
Filler 1¾" x 1/16" x 5⅜"
2 Bars 1¾" x ¼" x 5½"
19 Lb. Counterweight
Tie Rods
Plan of Ring, Plate and Tie Rods at Top of Mast
Bent Plate 4" x ¼" x 7"
55 Lb. Counterweight to Balance Drill
Mast
Trolley
Details of the portable jib crane

ported on a cast-iron base weighing 2,625 lb. In some shops where this crane is used, it is carried on a four-wheel hand truck. The maximum operating radius of the hook is 8 ft. The height from the bottom of the base to the bottom of the boom is 15 ft. 8½ in. The trolley and boom are counterbalanced as shown to permit easy



Assembly drawing of the portable jib crane

operation of the crane and tool. All of the parts are of wrought iron, with the exception of the base and counterweights, which are of cast iron.

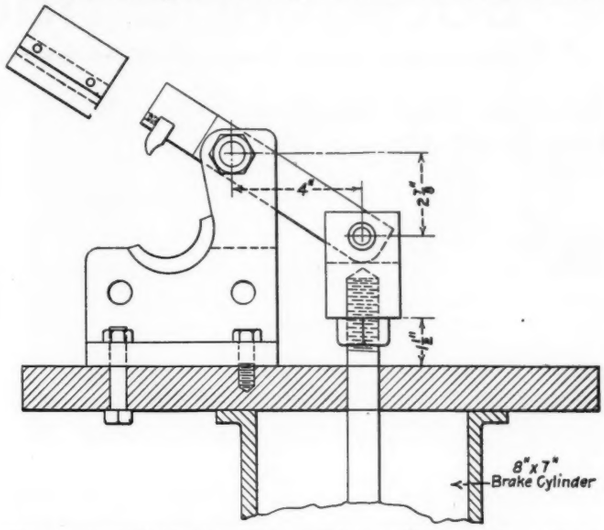
Device for Removing Fittings from Hose

WHEN it becomes necessary to remove fittings from scrap steam and air hose, the pneumatically-operated cutting knife shown in the drawing can be used effectively. It is comprised of an 8-in. by 7-in. brake cylinder, the piston rod of which actuates the cutting knife. The cylinder is mounted beneath the work bench to which is bolted the stand for holding the hose while it is being cut along the fitting stem. The stand is designed to hold steam hose but by inserting the bushing shown in the detailed drawing it can be used for cutting the smaller air hose.

The stand is built up by riveting a right-hand and left-hand section to a central block which is machined with a concave recess for inserting the hose and which is 1½ in. thick, 3⅜ in. high and 5⅞ in. long. The right-hand and left-hand sections are also machined with the concave recess for holding the hose during the cutting operations. When riveted to the central block the assembly has a solid base with a total width of 3 in. The central block does not extend into the upright part of the end sections, leaving the 1½-in. space between the uprights to be used as a fulcruming point for the cutting lever.

The cutting lever is attached to the piston rod of the brake cylinder at one end and fitted with the cutting blade at the other. Two cutting blades are used, one for steam hose and the other for air hose. Both blades have a thickness of ½ in. and a length of 3 in., but the width of the former is 1⅛ in. while the width of the latter is $1\frac{5}{16}$ in.

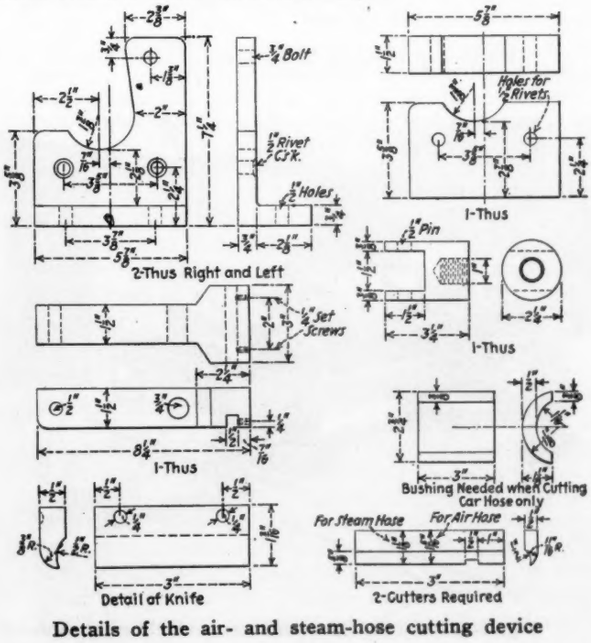
When cutting steam hose, the smaller blade is inserted



The pneumatically-operated cutting knife slits the air or steam hose parallel to the fitting after which the fitting can be removed readily

in the cutting lever and the hose is placed in the concave recess machined in the right-hand and left-hand sections and in the block riveted between them. As the air is applied, the cutting knife comes in contact with the hose, parallel with the center line of the hose fitting. The blade severs the hose along the fitting stem, after which the fitting can be removed readily by hand without any effort.

When cutting air hose, a bushing is placed in the recess of the stand. This bushing is machined with a $1\frac{1}{16}$ in. face radius suitable for holding the air hose firmly while the pressure against the hose and fitting is being applied. The cutter slits the hose through to the fitting, after which it can be removed easily.



Details of the air- and steam-hose cutting device

In the

Back Shop and Enginehouse

Testing Gas Engines For Rail-Motor Cars

By E. O. Whitfield *

WHEN a gas-electric rail car arrives in the shops for general overhaul under the unit-replacement system, the engine, generator and bed plate are removed from the car and a complete tested unit is installed. This procedure also applies to the trucks, compressors, and other equipment. Therefore, the only time that the motor car is out of service is that required to remove the units needing to be overhauled, and to install reconditioned and tested units.

The method and equipment used are shown in the three illustrations. Referring to Fig. 1, all engines scheduled for overhaul are dismantled, cleaned in the lye vat shown at the right of the illustration, repaired and tested on a hydraulic dynamometer. The dynamometer is located in the shed shown in the center background. A one-cylinder air motor is connected to the rear end of the shaft by means of a detachable coupling. This motor is used to operate the engine up to the point in the test where the engine is run with its own power. A belt over the flywheel, shown in Fig. 2, drives the sub-frame assembly which consists of the transfer case, transmission and air compressor.

Fig. 2 shows the interior of the dynamometer shed, with the hydraulic dynamometer *B*, in the foreground. The engine *A*, undergoing test, is shown in the background.

Fig. 3 is a view from the end opposite that shown in Fig. 2. The gage *B* is a tachometer which gives the speed rate of the engine in revolutions per minute. The dynamometer *C* is shown in the background. The two pipes *D* are for the exhaust.

* Mr. Whitfield is supervisor of rail-car maintenance and inspection on the New York, New Haven & Hartford.

Each engine undergoing test is run for one hour at full load and speed. Any defects noted during the test are corrected and the engine is then marked OK for service. A log is kept during the block test on which all features of operation are recorded at regular stated intervals. This procedure insures an engine which will perform satisfactorily in service, due to the fact that all irregu-

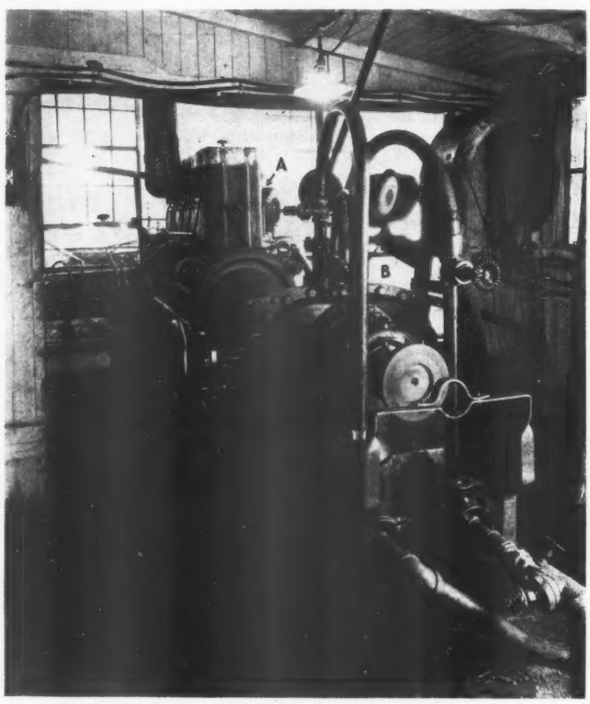


Fig. 2—Engine being tested on the dynamometer shown in the foreground

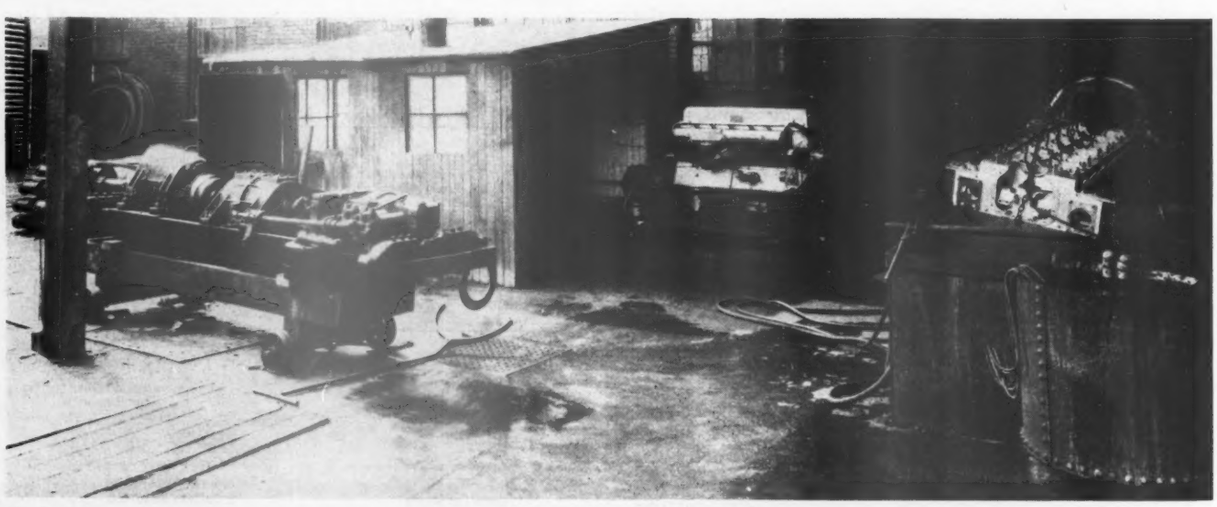


Fig. 1—Hydraulic dynamometer and cleaning tank—A transmission assembly is being brought into the shop

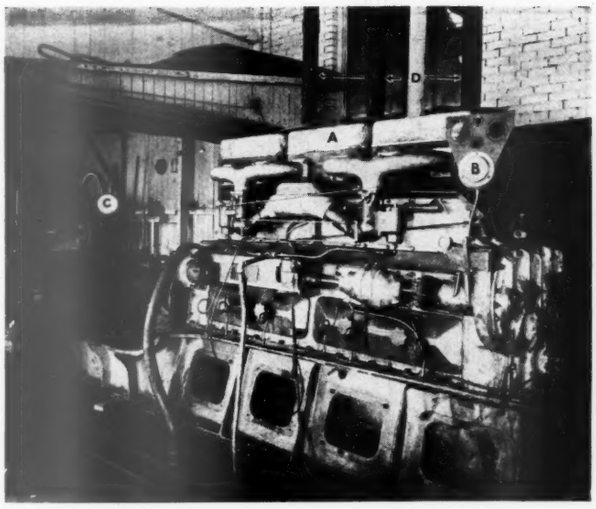


Fig. 3—Each engine is tested one hour on the dynamometer

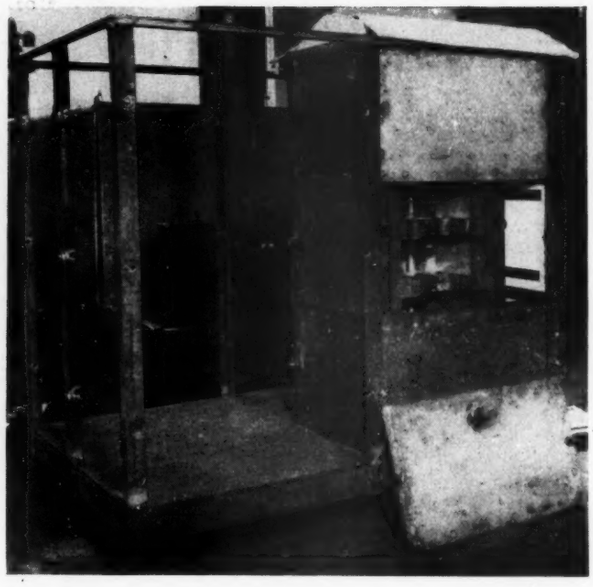
larities in engine performance are noted, rectified and checked under test.

Each engine is tested on its own bed plate and the various connections to the dynamometer are made to conform. The water tank and engine shown in Fig. 1, however, are on a bed plate which was made for a series of tests run in connection with a special investigation. The expenditure necessary in testing the different units of the power plant of rail-motor cars is economical, especially from the standpoint of increasing rail-car availability.

A Sectional Preheater

IN many locomotive repair operations which involve more or less extensive autogenous welding, preheating is required in order to take care of expansion and contraction. Too often the preheating device, or furnace, built up of firebrick, sheet iron and asbestos, is little more than a makeshift, the construction of which represents considerable lost time and some material for each weld. An unusually clever and convenient sectional preheating furnace has just recently been devised at the West Burlington (Iowa) shops of the Chicago, Burlington & Quincy, as shown in the illustration. The principal advantage of this preheater is its ready adaptability to hold locomotive forgings of various sizes and shapes, standing in either a vertical or horizontal position, and leaving little clearance space. It also provides for the removal of small panels, located immediately over the parts to be welded. The use of this preheating furnace tends to save time in constructing a temporary preheating enclosure of the required size, promotes fuel economy, saves time in the actual preheating operation, and permits the welding operator to work with maximum convenience at the immediate point of the weld without exposing other parts of the forging or casting to the atmospheric temperature.

The preheating furnace is 72 in. long by 48 in. wide by 60 in. high inside. It comprises essentially an angle and T-iron framework mounted on a hollow steel base which is divided into four quarters by interior partitions and is provided with a small rectangular opening to each, through which air from the shop air line can be supplied under pressure for starting fires quickly. Two of these rectangular openings are shown in the illustration. The



Sectional preheating furnace developed at the West Burlington (Iowa) shops of the C. B. & Q.

top plate of the base is ⅞ in. thick and is drilled with ⅜-in holes, spaced about 4 in. on centers to supply air for combustion to the furnace space above. The lower plate of the base consists of $\frac{3}{16}$-in. steel. Narrow end and side plates are welded in place to complete the hollow base construction. Individual air lines to the four sections of the base are piped so that air can be admitted to any one, two, or all of them, under equal pressure and controlled by a single master valve.

The corner posts of the furnace consist of 2½-in. angles, and the center posts of 2½-in. T-iron, connected at the top by smaller angles welded in place. The furnace walls are made of No. 18 gage iron panels, lined with asbestos millboard and provided in sufficient number to cover the sides, ends and top of the preheater, making it into one large furnace if necessary, or smaller sections, as required. In case a low casting requires preheating, the furnace need be built only high enough to cover it.

The particular job shown in the illustration is preheating a casting which requires one-fourth of the preheating furnace area for the full height. A layer of firebrick is placed on the base of the furnace as a protection against excessive heat and warpage of the heavy steel base plate. Care is taken to see that the air holes are not plugged and a charcoal fire is started, the casting being supported high enough above the firebrick to leave room for a bed of incandescent fuel. One or more of the side-wall panels is removed, as required, for greatest convenience in the welding operation.

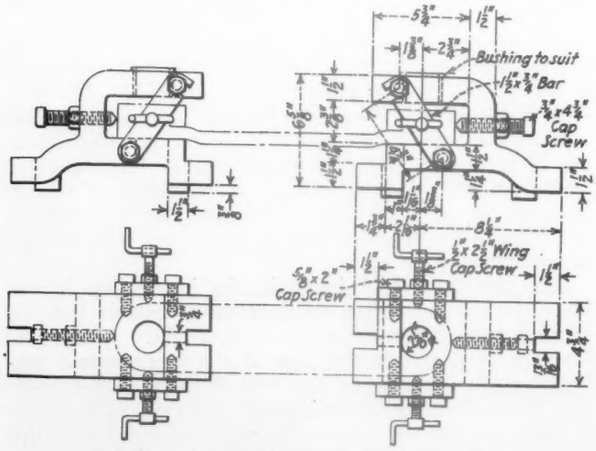
Jig for Drilling Spring Hangers

ONE of the important features of any locomotive shop is the care and attention given to spring-rigging repairs and the maintenance of standards which will assure satisfactory riding qualities and the delivery of the proper pressures to the front and back trucks, as well as to each pair of driving wheels. A group of forged spring hangers at the Chicago shops of the Chicago & North Western is shown in one of the illustrations. The

Four-spindle drill equipped with the jig for drilling spring-hanger holes

forging operation provides for the removal of the bulk of the material from the spring-pin holes to save time in subsequent drilling. These holes must be drilled out to the proper size, however, and the center distances accurately located.

A four-spindle drill is used for this purpose, a special



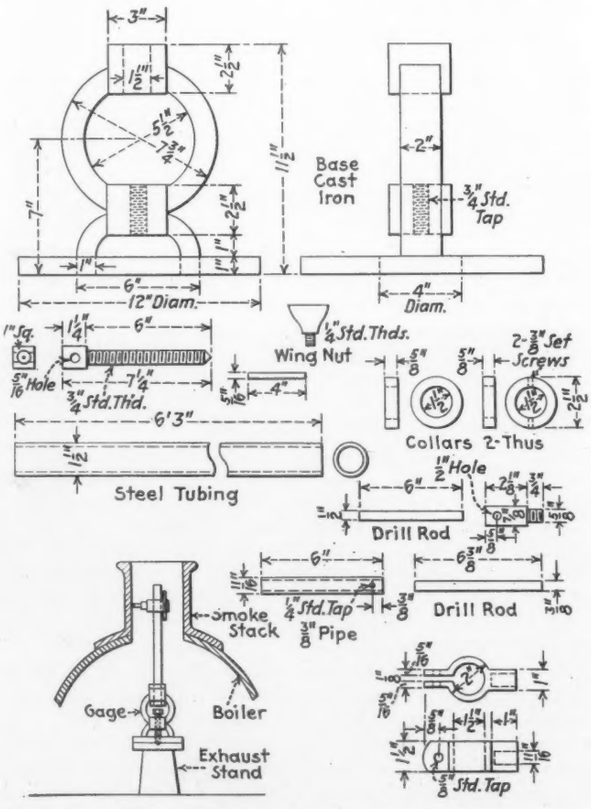
Details of locomotive spring-hanger drill jig

jig being employed, the details of which are shown in the drawing. This jig consists of two forgings, provided with recesses to receive the spring-hanger ends and capable of adjustment along the drill table to give the proper center distances. Two projections, or tongues, in the base of each forging fit in the T-slot, and each forging is securely fastened to the drill table by means of two T-bolts. Three set screws in each forging serve to position the spring hanger and a hardened-steel bushing guides the drill, the diagonally positioned holding or safety bar on the front of each forging having the upper bolt hole cut away on one side so that the bar can be quickly revolved out of the way for the insertion or removal of the spring hanger. The set screw in this bar is provided with a handle so that it can be readily set up without the use of a wrench. Once the jig is properly located on the drill table and the set screws adjusted for a certain size of spring hanger, the only additional motion necessary for the drilling of the spring-hanger holes is the tightening or loosening of the cap screw in the safety bar and swinging it into or out of position for holding the hanger. The hardened-steel bushings are a hand-fit in the forgings and are provided in different sizes to accommodate the different sizes of spring pin holes. By the use of this jig, spring-hanger holes may be drilled out with every assurance that they will be of the proper size and accurately located.

Gage for Setting Up Smoke Stacks

ONE of the methods most frequently used for alining and setting up a smoke stack employs a gage similar to the one shown in the drawing. This gage, designed and used on an Eastern road, consists of a suitable base for mounting the gage on the exhaust stand, a 6-ft. 3-in. section of 1½-in. o.d. steel tubing, collars for securing the tubing to the base, and a clamp which forms the holder for the scribber.

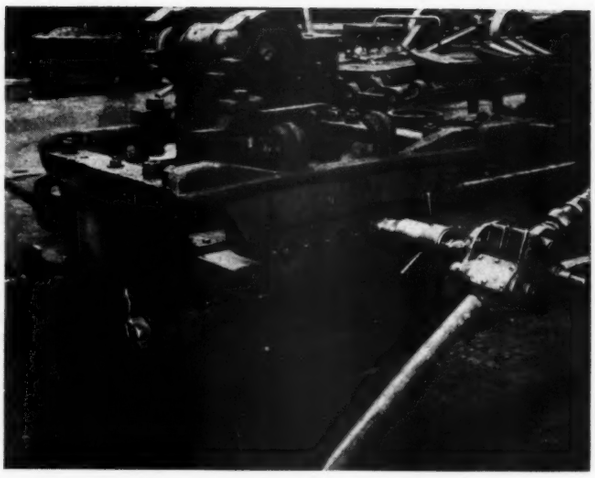
The base of the gage is 12 in. in diameter, 11½ in. high and is of welded construction. The base plate is 1 in. thick, bored to a diameter of 4 in. at the center. Two 1½-in. by 2½-in. by 3-in. steel blocks are welded in the positions shown on the drawing, being separated by the 1⅛-in. by 2-in. curved pieces of bar steel. The lower block is drilled and tapped for the insertion of a 1¼-in. by 6-in. pointed centering screw, which is used to center the gage above the exhaust stand. The center is usually located by wedging a piece of wood across



A gage which can be used effectively for setting up smoke stacks

the opening of the stand and locating the center on it, using morphodite calipers. The point of the centering screw is then alined with the center of the stand thus found.

The upper block is drilled to a diameter of 1½ in. for the insertion of the section of steel tubing, which is held securely in a vertical position by clamping a collar on the tubing at each face of the block. A split clamp, tightened by a ¼-in wing nut, is used as a holder for the scriber which bears against the inside of the stack, indicating the direction in which the stack has to move in order to center it. The scriber must necessarily be used at several points in order to insure the stack being perpendicular as well as centered, small wedges being used under the stack on the outside of the smoke box to level it as necessary. It is generally considered advisable to set a level against the stack extension, which has a plane machined surface for attaching the petticoat, to ascertain if the stack is perpendicular, thus checking the setting as made by the gage described.



Another view of the boring jig, set up ready for operation

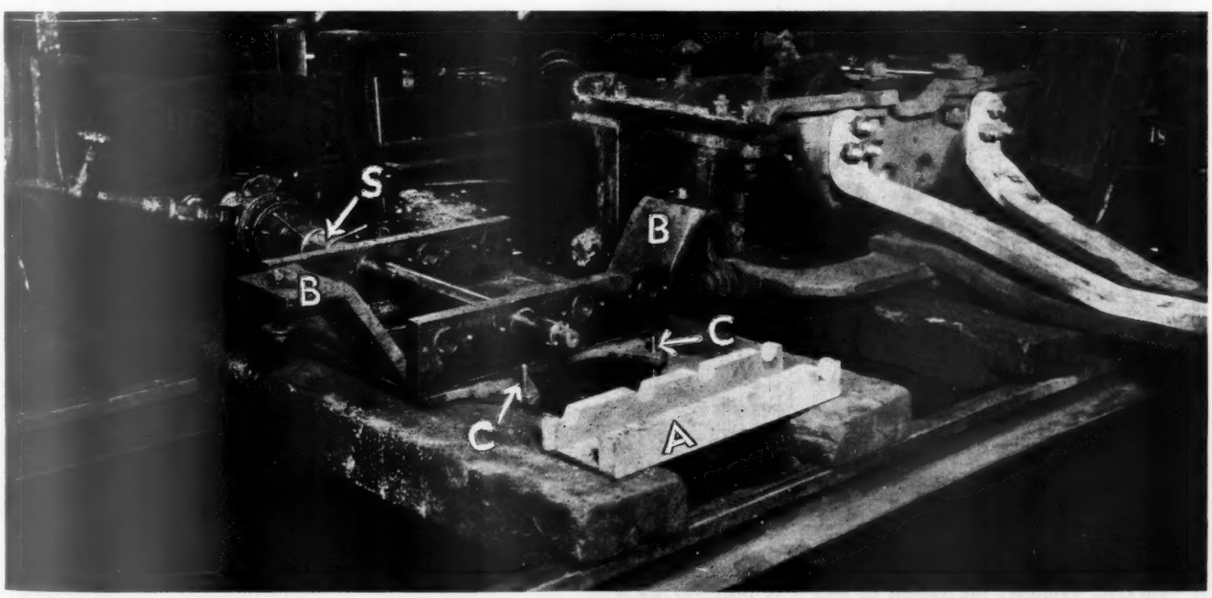
Reboring Swing-Link Seats

THE kind of repairs given to engine trucks in the backshop has an important bearing on the riding qualities of a locomotive, as well as on rail stress, flange wear, etc. With a view to repairing two-wheel engine trucks and returning them to service in as nearly as possible the same condition as when new, the swing-link seats in the main cast-steel frame are built up by welding at the Silvis (Ill.) shops of the Rock Island and re-machined to standard blueprint size and location by means of the jig shown in the illustrations.

In overhauling this type of truck, the cast-steel frame is cleaned, examined for cracks, excessive pedestal wear, if any, corrected, radius bars renewed, if necessary, and all parts tightly bolted. There are four holes, front and back, in the main frame to accommodate the swing-link pins which are subject to rather rapid wear, owing to the heavy pressures and impossibility of preventing abrasion due to excessive grit or dirt in this exposed location. Practically all of the wear occurs on the lower half of the holes, which are accordingly built up with the acetylene welding torch, using soft steel welding rod and the welding gage *A*, shown in one of the illustrations. This gage fits around the engine-truck casting and eliminates much of the guesswork in building up the worn part of the holes, leaving a little extra stock for machining.

The jig for re-machining the swing-link seats is shown in the same illustration, assembled as it would be after application to the engine truck and being used for the machining operation. The jig consists of a ¾-in. steel base plate, on which are mounted two narrow vertical plates, each of which has four 1¾-in. bronze-bushed holes, spaced according to the blueprint dimensions of the swing-link holes in the engine truck and accommodating a boring bar which is driven by an air motor. The boring bar is equipped with two 2-in. double-acting high-speed-steel cutters, enabling two holes to be bored at one time. Feed is obtained by means of a threaded sleeve *S*, which screws onto a bushing bolted on one of the vertical plates and better shown in the other illustration.

The jig is secured to the engine truck frame by two small bolts extending through the oil holes (journal box)



Welding gage *A* and jig for boring engine-truck swing-link seats, used at the Silvis shops of the Rock Island

and the bracket *BB*, which is in turn fastened to the baseplate by six cap screws so that it can be removed from the base in assembling or taking down the jig. Four additional set screws, two of which are shown at *CC* in the base, can be tightened and thus assist in holding the jig rigid during the cutting operation. It will be observed that the bolt holes in the bracket *BB* are slotted, which permits the jig to bear against the back pedestal with varying widths of pedestal ways and thus take the thrust of the boring bar. Provision for centering the cutters is afforded by two steel taper pins which, at the same time, hold them tight.

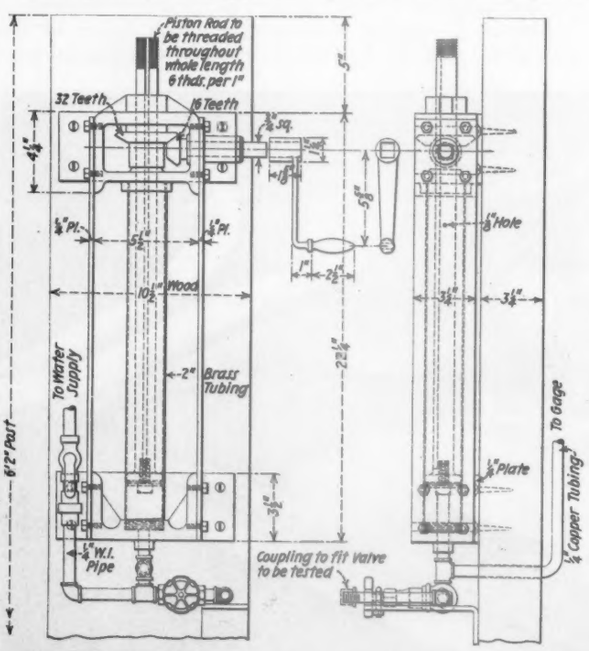
The use of this jig assures not only that the swing link seats will be accurately machined in the right location, but that they will be in line in both the front and back sections of the casting and give a uniform bearing. One thing which has been noticed since this jig was used at Silvis shops is that swing-link seats built up and re-machined with this device apparently give a much longer service life than those machined in the original metal. In other words, they last for several shoppings, where, formerly, excessive wear developed in a single shopping period.

Hydraulic Testing Device For Globe and Angle Valves

WHEN it is desired to test globe or angle valves to pressures higher than those available in the backshop or enginehouse, the hydraulic testing device shown in the drawing can be used satisfactorily. It consists of a cylinder made of 2-in brass tubing in which a piston slides, actuated by a hand crank and suitable gearing. The piston rod is threaded throughout its entire length and is keyed to the top bracket to keep it from revolving as the gear, which actuates it, is turned by meshing with the beveled pinion gear keyed to the shaft of the hand crank.

The cylinder is supported by two vertical strips of ½-in. plate, 3¼-in. wide, which are bolted, top and bottom, to angles of ½-in. plate, the latter forming the brackets for supporting the device. Water is piped to the cylinder through an angle cock, which is shut off when sufficient water enters the cylinder. A globe valve is inserted between the cylinder and the coupling used to attach the valve being tested.

When using the device, the valve being tested is attached to the coupling and the globe valve opened. By turning the crank, forcing the piston downward, a pressure is built up behind the seat of the valve, the pressure being recorded on a single-hand gage which is coupled in the line between the cylinder and the globe valve.

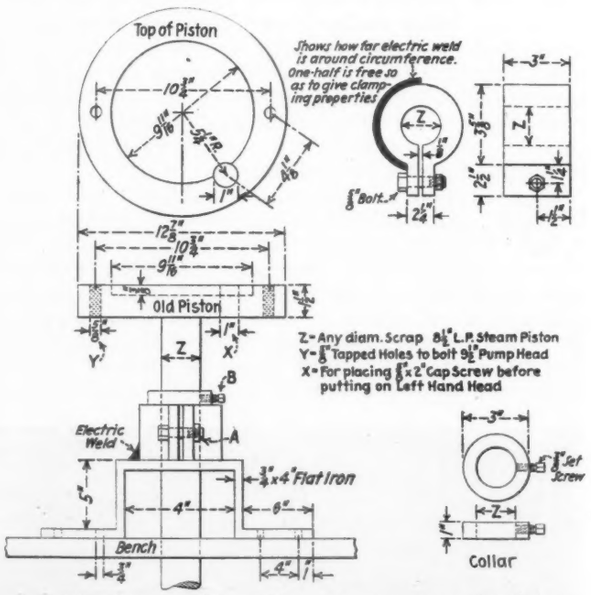


A hydraulic cylinder, the piston of which is operated by a hand crank, is used with the testing device to build up pressures beyond those available from regular shop sources

Stand for Repairing Air-Compressor Heads

By E. G. Jones

THE repair stand shown in the drawing has many commendable features with respect to the repairing of 9½-in. air-compressor heads. By the adjustment of the collar on the stand rod, the stand can be raised or lowered to suit the convenience of the repairman. By this collar acting as a vertical thrust bearing, the stand,


Top of Piston
Shows how far electric weld is around circumference. One-half is free so as to give clamping properties
Old Piston
Z= Any diam. Scrap 8½" L.P. Steam Piston
Y= ⅝" Tapped Holes to bolt 9½" Pump Head
X= For placing ⅝" x 2" Cap Screw before putting on Left Hand Head
Electric Weld
¾" x 4" Flat Iron
Bench
Collar
Set Screw

Stand for repairing 9½-in. air-compressor heads

with the compressor head in place, can be revolved at will when the split clamp is loose. This feature is convenient in that the large and small head covers can be faced for 180 deg., the repairman to apply the bolts, simply by revolving the stand.

When the bolts are to be tightened, the split-clamp nut is turned with a wrench so as to clamp the stand rod which will hold the stand and head rigid.

Referring to the drawing, the head is bolted to the piston. The clamp nut *A* is loosened at the clamp and the piston is raised to the desired height. The nut *A* is then tightened. The collar rests on top of the clamp and is held by the set screw *B*. The loosening of the clamp nut *A* causes the weight to rest on the collar. The compressor head may then be turned to any position.

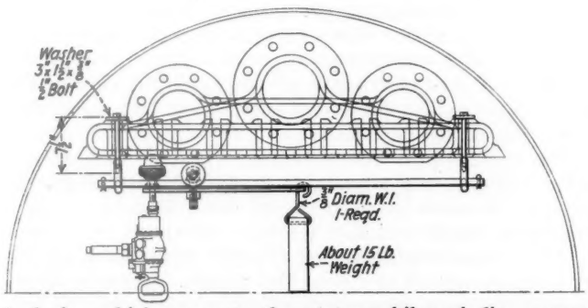
The stand is made of an old low-pressure steam piston and turned down in a lathe as shown. A recess is added

so as to permit a fit to the head shoulder when the compressor head is applied. A large hole is drilled in the stand head as shown so as to allow the pump-head bolt under the left main-valve cylinder head to remain in place. The compressor head is held rigidly to the stand head by two standard 5/8-in. cap bolts with tapped holes in the stand head.

Device for Grinding Superheater Header Joints

WHEN grinding a complete set of superheater header joints in the smoke-box the mechanic frequently tires as a result of holding in a vertical position the small air motor used for operating the grinding tool. To eliminate the necessity of having the mechanic hold the air motor in the usual overhead position, the device shown in the drawing was designed to take the weight of the motor, thus permitting him to devote his entire attention to the quality of the joint.

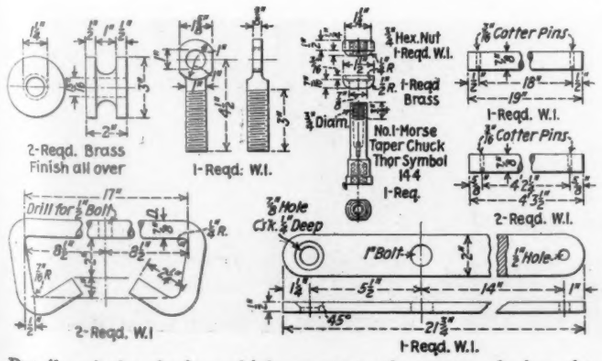
The device consists of two rods suspended from the



A device which supports the motor while grinding superheater header joints

superheater header along which runs a pair of wheels, from the axle of which is suspended an I-bolt. The bolt serves as a fulcrum for a rod on one end of which is suspended a 15-lb. weight to balance the weight of the motor. Two ½-in. by 7½-in. bolts, held in position by 3-in. by 1½-in. by ⅜-in. washers, are used to suspend the device from the header. The bolts are directly attached to two hooks made of ⅞-in. round iron which in their finished shape are 17 in. long. This piece is bent in such a way as to support parallel bars, one at the front of the header and one at the back. The bars serve as runways for the pulley wheels which are connected by a ⅞-in. by 18-in. round bar, from which is suspended, by means of an I-bolt, the bar used to support the 15-lb. weight and air motor. This bar is a ½ in. thick, 2 in. wide and 21¾ in. long and has a ½-in. hole drilled at one end to serve as a means for inserting a ⅜-in. hook for supporting the 15-lb. weight. The other end of the bar is drilled and countersunk for the insertion of a long No. 1 Morse taper chuck, fitted with a brass bearing contoured to fit the counterbore. This bar is drilled 5½ in. from the end to which the motor is attached, for the insertion of the I-bolt suspended from the bar connecting the two pulley wheels. The ratio of the distance between the ends of the bar and the fulcrum point is about three to one to eliminate the necessity of hanging a weight in excess of 15 lb. at the end of the bar.

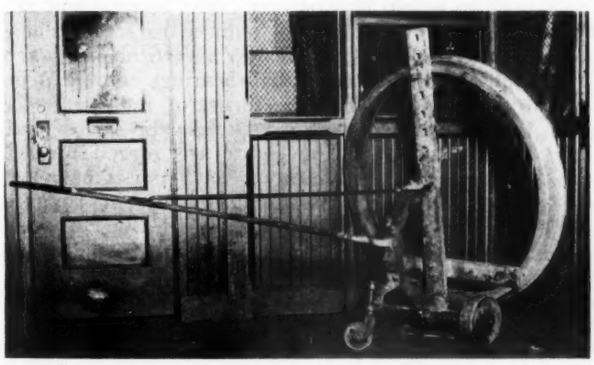
When in use the parallel rods are suspended in the manner described above, and the pulley wheels and bar for supporting the weight and motor are mounted in position. The motor, 15-lb. weight and the bar used to support them are assembled as a unit which can roll from one end of the header to the other. The assembled unit can thus be set in any position to reach all of the header unit joints without changing the setup.



Details of the device which supports the motor during the grinding of superheater header joints

Driving-Wheel Tire Wagon

A USEFUL wagon for hauling driving-wheel tires in and about an enginehouse and which can be used effectively in placing the tire against the wheel on which it is to be shrunk, is shown in the illustration. The wagon consists of an upright member mounted on an axle fitted with two 8-in. roller-bearing wheels. A semicircular brace, bolted to the axle and the middle of the upright member, is used to attach a swiveling trailing



A tire wagon which maneuvers a tire against a wheel without having to roll it

wheel, the use of which makes the wagon capable of supporting a tire in a vertical position without the necessity of steadying it with the tongue.

A cross bar is bolted near the bottom of the upright member and 2 in. above the top of the wheels. When a tire is placed on the wagon, it is supported by a hook, set in one of five square holes punched into the top of the upright member, and is kept away from the wheels by the cross bar at the bottom.

The important feature of the wagon is the small-diameter roller-bearing wheels. These permit the setting of a tire against an intermediate driving wheel without rolling it into position even though there might be considerable difficulty encountered because of obstructing parts of outside valve motion and its various supporting brackets.

NEW DEVICES

Pattern Millers for Small Shops

A MACHINE for milling patterns, which is designed to meet the particular needs of small pattern shops and which is designated as the Wadkin Junior pattern miller, W. K., has been introduced recently in this country by the Oliver Machinery Company, Grand Rapids, Mich. The machine is designed so that at least 90 per cent of all pattern and core-box work can be generated mechanically, being sufficiently flexible to give a combination of movements that will operate on geometric and irregular patterns. It offers a wide range of adjustments, quick-action fine-feed motions, and stops for automatically controlling the limits of the cutting. The machine is adaptable to a large variety of work and can be handled by the average workman.

The main frame is a heavy casting having machined slides which carry an overhanging arm. This arm carries the spindle head and is raised and lowered by hand motion through the medium of a worm and worm wheel and a large hand wheel placed in a convenient position on the arm. The distance between the center of the cutter spindle and the face of the body frame is 28 in. The spindle head swivels between the vertical and horizontal, the principal angles being indexed and located by a taper spring plunger engaging with suitable holes. Intermediate angles are registered by a scale graduated in degrees, and the head secured by a locking handle. When the spindle is in the horizontal position the maximum height between the cutter spindle and the work table is 18 in., which is reduced to 15 in. when the spindle is swivelled round into a vertical position.

The spindle runs in heavy ball bearings contained in dust-proof housings while the thrust of the spindle is taken by ball bearings arranged to take the thrust load only. The spindle and the chuck are forged in one piece and the chuck is bored to a No. 5 morse taper. A wide range of cutter holders and blocks, carrying various types of cutters, can be used to give the machine an extensive scope of working.

The spindle is fed into the work by a hand lever mounted in the center of the spindle head. This motion is arranged with a spring plunger to give definite depths of feed and is also provided with limit stops. This facilitates the operation of the machine, and is designed to prevent the possibility of spoiled work and to insure a higher degree of accuracy.

The drive is transmitted to the cutter spindle through the medium of a spindle running the full length of the arm. At the main-frame end is a pulley driven by belt from the motor pulley or the countershaft in the base of the main frame. The belt is arranged so that the raising and lowering of the arm does not affect the correct tension of the belt.

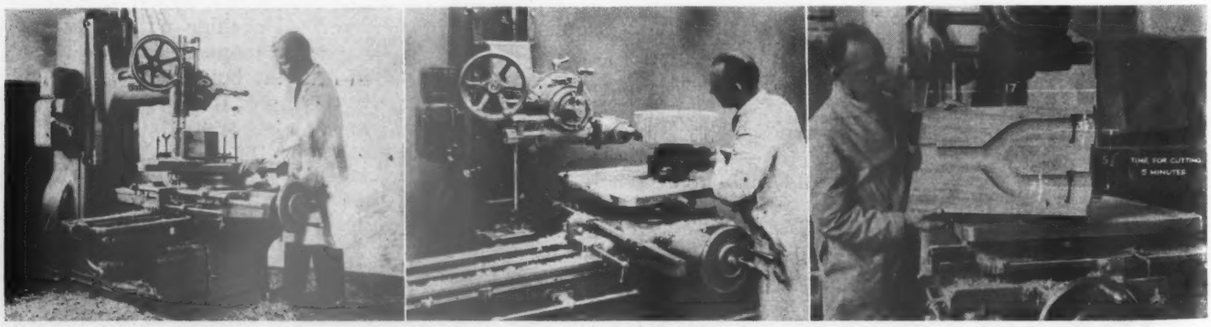
At the cutter-spindle head the drive is transmitted by spiral gears with ground teeth. These gears are totally inclosed and arranged to run in grease. This method of drive allows the spindle to drop below the level of the work to enter a core box with its axis parallel to the surface of the work. It also allows the cutters to be carried close to the bearings, dispensing with long boring bars. Another advantage is that this drive enables the spindle to occupy any angular position which often saves resetting the work and increases the range of the application of the cutters.

Two spindle speeds of 4,300 r.p.m. and 2,700 r.p.m., respectively, to suit the various sizes and types of cutters, are provided. These speeds are obtained either by means of a variable-speed motor when the machine is self-contained electrically-driven or, in the case of the belt-driven model, by a two-speed gear box connected to the main driving shaft.

The table is provided at regular intervals with tapped holes for securing adjustable holding-down clamps. It has two motions at right angles controlled by a screw and hand wheel, and also a rotary movement by a hand lever arranged with a spring-plunger taper pin engaging in holes giving all the principal angles. It has a longitudinal traverse movement of 44 in. and a lateral traverse movement of 22 in. These movements combined with the stop devices allow the cutters to operate on complicated forms and various radii semi-automatically.

General Electric Nitriding Furnaces

THE General Electric Company, Schenectady, N. Y., announces a complete line of batch-type nitriding furnaces for use at temperatures up to 1,200 deg. F. Included in the line are two sizes of vertical cylindrical-type furnaces, with a fan for circulating the ammonia gas, and two sizes of box-type furnaces, complete with charging trucks for handling the retorts.



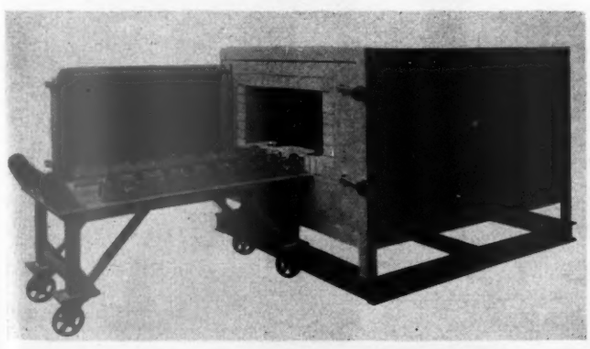
The Wadkin Junior pattern-milling machine which is designed to give a combination of movements that will generate geometric and irregular-shaped patterns—It is for use in small shops

The vertical-type furnaces consist of an outer shell containing the heating units of nickel-chromium resistor ribbon and an inner retort which is inserted into the furnace through a hole in the cover. The retort is made in two parts, the upper part containing the motor and fan and the lower part containing the charge to be nitrided. The fan is of the uni-directional high-pressure type and is used to insure complete diffusion of the ammonia gas through the charge. The upper half of the retort is part of the cover and is heavily insulated to keep the motor at operating temperature and to keep the radiation losses at a minimum. The lower part of the retort is an alloy-steel container, completely welded to be gas tight. A basket is provided for the charge and is supported within the retort. A close-fitting alloy steel hood covers the fan and fits down on the basket, thus guiding the circulation of gas through the charge.

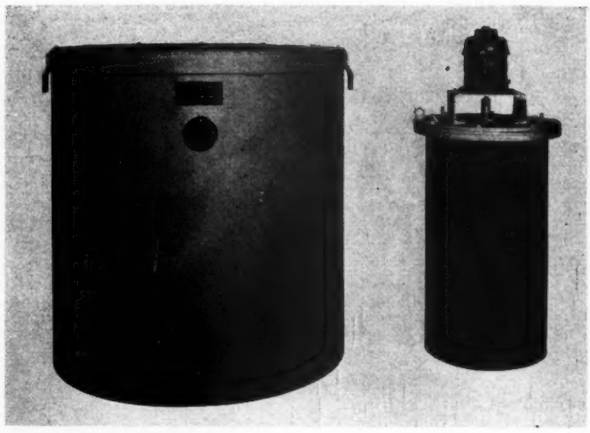
The two halves of the retort are joined securely together by means of bolts and nuts through metal rings attached to the outer circumference of each part. Gas leakage is prevented by means of a seal, consisting of an asbestos ring gasket compressed between the two rings. The inlet and outlet for the ammonia is through the cover, so that the complete retort can be withdrawn from the furnace at the end of the nitriding cycle and allowed to cool outside the furnace. The furnace can be recharged immediately by utilizing a spare retort or, in case the production does not warrant a second retort, the time of cooling is greatly reduced by permitting the charge to cool outside the furnace.

This furnace is available in two sizes. The smaller furnace has loading dimensions 14⅝ in. diameter by 18 in. in depth and is rated at 23 kw., 220 volts, 3 phase. The larger furnace has loading dimensions 20½ in. diameter by 26 in. depth and is rated at 30 kw., 220 volts, 3 phase.

The box-type furnaces are small and compact, requiring little head room and floor space. Light-weight refractory brick is used in the furnace and a simple swing-type door with screw clamps and an asbestos gasket to prevent heat leakage is provided. A rack and roller track is attached to the floor of the furnace to assure ready insertion and removal of the alloy-steel retort used to hold the charge. The cover of the retort is provided with a down-turned lip which engages in a groove provided around the top of the retort itself. The sealing medium for the retort is an asbestos and aluminum gasket compressed between the lip and groove by heavy bolts and nuts around the perimeter of the retort. Inlet and outlet tubes for the gas are of pure nickel tubing, extending through cone-shaped bushings in the back of the furnace. A charging truck, equipped with rack and rollers, can be supplied for handling the retort.



Typical box-type nitriding furnace with charging truck in place



Vertical cylindrical nitriding furnace with retort withdrawn

The furnace is available in two sizes, the larger being rated at 40 kw., 220 volts, 3 phase and having retort dimensions 28 in. wide by 48 in. long by 11 in. high. The smaller size is rated 30 kw., 220 volts, 3 phase, and has retort dimensions 19½ in. wide by 48 in. long by 11 in. high.

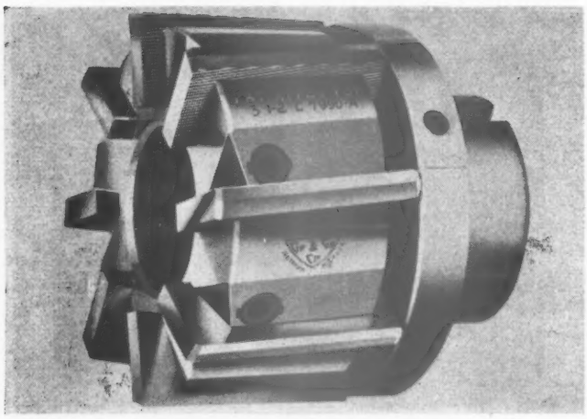
Because of the long holding cycles of the nitriding process where only the radiation losses of the furnace, plus the small amount of heat required to raise the temperature of the ammonia gas need be supplied, it is advisable to cut down the input to the furnace after the charge is up to temperature. The control panels of all General Electric nitriding furnaces are provided with a switch by means of which the input may be reduced to one-third of the rated value. A unit package containing all valves, gages, etc., all dissociation apparatus and glassware, mounted in a glass panelled steel cabinet, can be furnished with the furnaces.

Serrated-Blade Expansion Reamers

GODDARD & Goddard Company, Inc., Detroit, Mich., recently brought out a serrated-blade expansion finishing reamer which provides quick adjustment, positive positioning and long life of blades. The tool is an addition to the line of flat wedge-type reamers introduced about a year ago and meets the demand for a tool with quicker adjustment. The reamer consists of four component parts: An alloy heat-treated steel body, high-speed (or other cutting metal) blades, an adjusting nut, and a cam lock.

To make an adjustment of the cutters a set screw in the adjusting nut is loosened and the nut turned back one full turn. The blade cam lock is then released by turning the adjusting nut 90 deg. to the right. The blades are then slid back against the adjusting nut, after which the adjusting nut is turned against the blade until the required size is established. The cam lock is returned to its locking position by turning the adjusting nut 90 deg. to the left, after which it is clamped in position by tightening the set screw in the adjusting nut.

Blade adjustment for expansion is always toward the shank of the reamer as the blade slots are deepest at the reamer ends. As this longitudinal movement is only slightly more than 3/16 in. before the blade is moved out radially to the next serration and forward again to its initial position, the blades are held firmly in a large



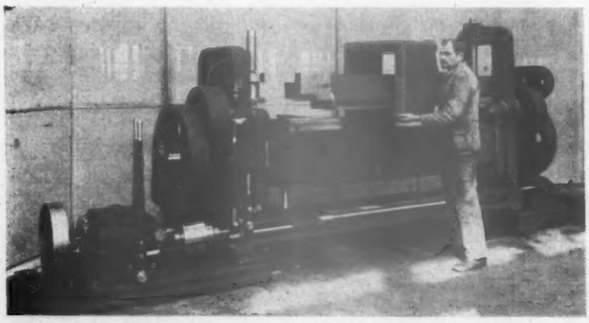
The Goddard & Goddard serrated-blade expansion finishing reamer

area contact with the body. Blades register at all times in the serrations and, as they do not contact at the bottom of the tooth slot, any blade can be replaced at any time by a new one without effect upon the remainder of the blades.

Long blade life is offered in this design, 1-in reamers allowing .187 in. expansion life, 2-in. reamers allowing .250 in., 3-in. reamers allowing .442 in. and 4½-in. reamers and over allowing .625 in. expansion life. Eight blade sizes are required for the entire standard finishing reamer range of 1 in. to 6 in. diameters. Shell, taper, and straight-shank blades are the three standard styles which are available. Standard blades can be used on certain special applications. The cam-lock feature can also be combined, on many special jobs, with the standard roughing reamer blades which have radial serrations (as compared with longitudinal serrations on standard finishing reamers). This is an application which can be used in combined reamers and spot facers, or reamers and chamfering tools or, as frequently is the case, in combinations of all three.

The Schatz Universal Brake

THE Universal brake, rounding and box forming machines recently placed on the market by the Schatz Manufacturing Company, Poughkeepsie, N. Y., are designed with either hand or power drive in widths from 40 in. to 20 ft. for handling plates, ranging from the thinnest to those 1⅛-in. thick. They can be had with or without a swing-out top clamping bar, the latter being preferable for making closed forms, trays, boxes, tanks, etc., from one sheet of material.



One of the Schatz power-driven Universal brake-rounding and box-forming machines

Aside from the swing-out top bar feature, other characteristics include a high adjustment of the top clamping bar, which on the largest power machine goes to 25½ in., and the lowering of the bottom clamping bar and folding bar (apron) as much as 11¾ in. The high upward adjustment of the top bar permits the use of high-angle forming blades having a usable height of at least 80 per cent of the top-bar adjustment, for the forming of narrow channels, trays with high walls, besides the accommodation of bulky work between the bars.

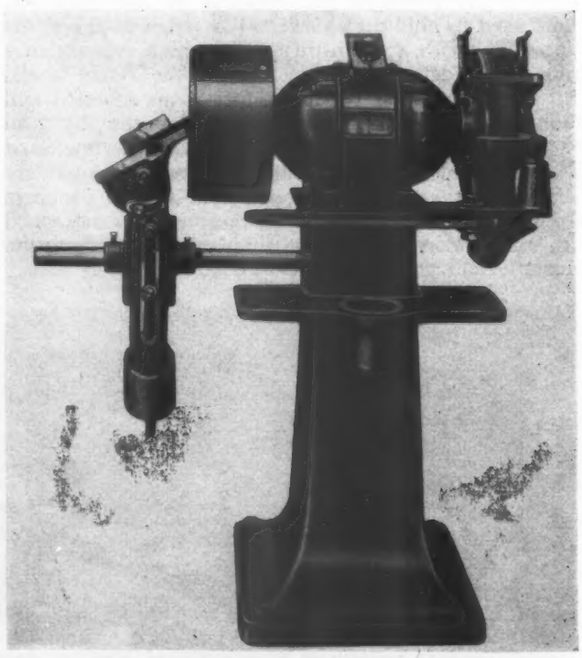
The lowering of the bottom clamping bar and folding bar is resorted to when bends with a radius are made. The maximum radius that can be bent is equivalent to the maximum downward adjustment of the lower bars. These adjustments are made according to conveniently located graduated scales. The wide opening between the bars permits the introduction of round or rectangular mandrels, the former for tube forming or rounding and the latter for making smaller closed forms than can be made over the larger standard top bar.

The blades in the top bar can be readily interchanged without the use of screws or bolts of any kind. The blade in the folding bar is slotted for quick change and is reversible for folding or bending thick and thin plates. Boxes having wide or narrow inside or outside flanges can be formed from one sheet of metal, which is also an advantage on many other classes of work.

Grinder for Tungsten-Carbide Tools

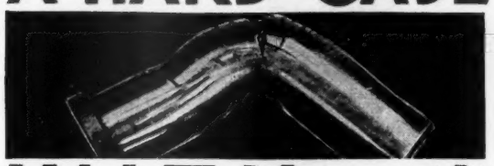
A GRINDER, designed especially for sharpening tungsten-carbide and high-speed tools, which has been designated as the U. S. Tungsten-Carbide Tool Grinder, has recently been placed on the market by the

(Continued on next left-hand page)



The U. S. Tungsten-Carbide grinder

A HARD CASE

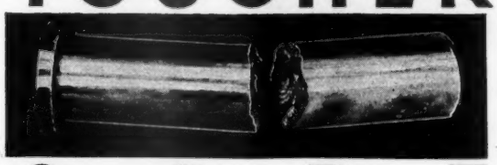


Wrought Iron

WITH A

Agathon Nickel Iron

TOUGHER



Steel

CORE

■ A hard case is worthless unless the core of a pin or bushing is sufficiently tough to withstand the shocks and stresses encountered in locomotive work.

■ Agathon Nickel Iron combines toughness of core with exceptional case-hardening qualities.

■ Agathon Nickel Iron is uniform all the way thru, with no slag seams lurking to spoil partly finished material.

■ Agathon Nickel Iron may be machined to size, polished, carburized and quenched from the pot without spoiling the surface for smoothness. Warping is practically negligible.

■ Try this modern alloy iron for all case-hardened pins and bushings.

AGATHON NICKEL IRON

Central Alloy Division

REPUBLIC STEEL

CORPORATION

MASSILLON, OHIO

The cup wheel and adjustable table for grinding tungsten-carbide and high-speed tools

United States Electrical Tool Company, Cincinnati, Ohio. The tool rest of this machine is the outstanding feature. It is comprised of an adjustable table and a sliding guide which, together, hold the tool securely at any desired angle against the cup wheel. It is designed to prevent the mechanic from grinding away more of the tool than is necessary to sharpen it, and to grind a cutting edge on the tool which will prevent chattering and breaking away when in use. The tool rest is provided with a protractor in order that it might be set accurately at any desired angle for grinding the tools.

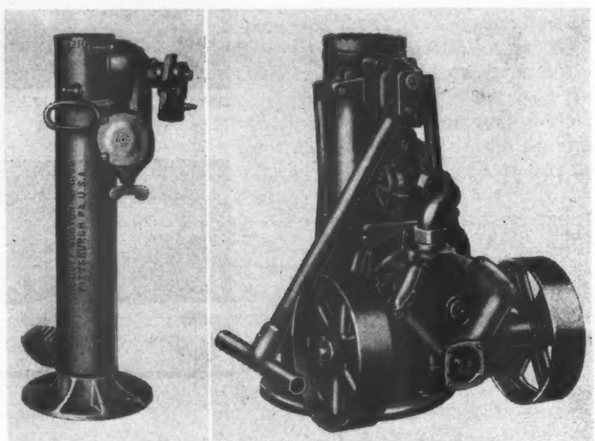
Other features of this machine include a 2-hp. motor which operates at a speed of 1,750 r.p.m. furnished in any standard a. c. or d. c. voltage; push-button control; SKF ball bearings, and a boiler-plate wheel guard which can be adjusted for wheel wear. The grinder can be furnished with a cup wheel and swinging table at one end and a conventional flat-face grinding wheel at the other end, as shown in the illustration, or with a cup wheel and swinging table at both ends.

Duff-Norton Jacks for Locomotives and Cars

IN the illustration is shown a 100-ton jack operated by an air-motor and a governor-controlled self-lowering jack which have been designed for engine-house and car-shop service, respectively. The 100-ton jack is mounted on wide-tread wheels and is equipped with a long collapsible trundling handle which folds out of the way when not in use. The load supported by the jack is carried on a phosphor-bronze nut, pressed and pinned into the end of the jack standard which is constructed of high-strength steel, made to metallurgical specifications. The top piece of the standard is of steel and is drop forged.

The 100-ton jack is equipped with an automatic shut-off device which operates when the standard reaches the safe limit of its lift or depth. It is also provided with an up-and-down throttle control, the lever of which is placed in a guarded position to prevent accidental movement. The bearing points of the valve controlling the operation of the air motor are lined with bronze bushings, while the steel parts are made of rustless, stainless steel; these being used to eliminate clogging and rusting of the air passages. In addition, a removable screen plug with a bronze screen is provided to prevent cinders and dirt from entering the motor. All the important parts of the jack are mounted on annular ball bearings, while those parts subjected to thrust as well as radial loads are mounted on Timken roller bearings.

The 100-ton jack, designed for heavy-duty locomotive service, weighs 415 lb., stands 26 in. high and has a lift of 14 in. The diameter of the base is 14 in., while the diameter of the head is 6⅛ in. With the use of a Y air-hose connection, two of the jacks can be operated as a unit by one attendant.



Left: The Duff-Norton governor-controlled self-lowering jack for empty-car maintenance service—Right: The 100-ton locomotive jack which is operated by an air motor and which is equipped with an automatic shut-off device

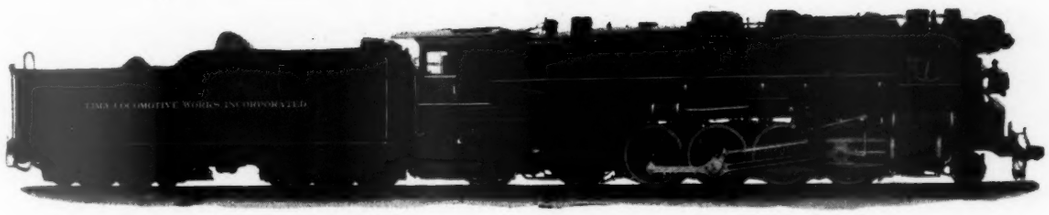
The governor-controlled self-lowering jack is constructed with a one-piece shell and is designed especially for empty-car maintenance service. It is equipped with a toe lift for truck work, a control lever for lowering, Timken roller bearings, and self-lubricated working parts mounted in a grease-packed housing. The features of the jack are its fast lifting speed, its self-lowering quality, and the foot lift which facilitates spotting the jack when there is insufficient clearance for the load on the top of the jack. It weighs 109 lb., stands 28 in. high, and has a lift of 17 in. The base is 10 in. in diameter, while the diameter of the head is 4¾ in. Both jacks are recent developments of the Duff-Norton Manufacturing Company, Pittsburgh, Pa.

Portable Hand Grinder and Buffer

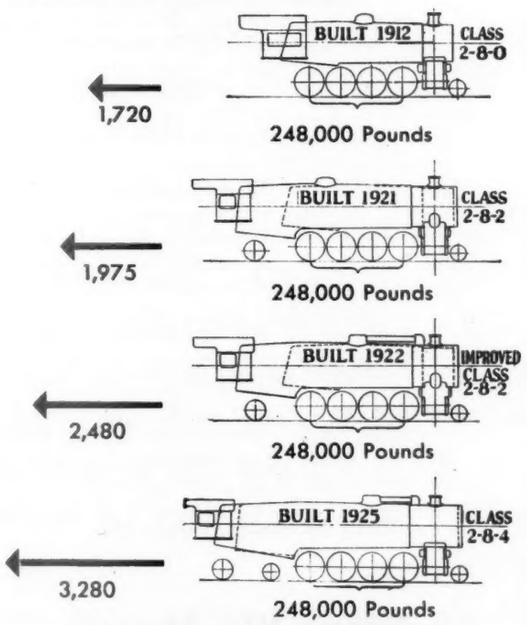
IN the illustration is shown a portable electrically driven hand grinder and buffer which has recently been placed on the market by the Standard Electrical Tool Company, Cincinnati, Ohio. The grinder is equipped with a ½-hp. General Electric Hy-Frequency motor for operating on 220-volt, 180-cycle, 3-phase current and is furnished with 6-in. by 1-in. high-speed Bakelite wheels which have a ⅝-in. bore. The speed of the

(Continued on next left-hand page)

MORE POWER
for the
SAME WEIGHT



Maximum
Draw Bar Horse Power



This chart shows the

INCREASE IN HORSE POWER

that has been made possible with the

SAME DRIVING WHEEL WEIGHT

by the development of the Super-Power Locomotive.

Super-Power Locomotives are capable of delivering *maximum draw bar horse power* per unit of weight — making possible *increased train speed* together with *increased train tonnage* and great *economy in fuel.*

LIMA LOCOMOTIVE WORKS

Incorporated

LIMA - - - - - OHIO

LIMA LOCOMOTIVE WORKS INCORPORATED

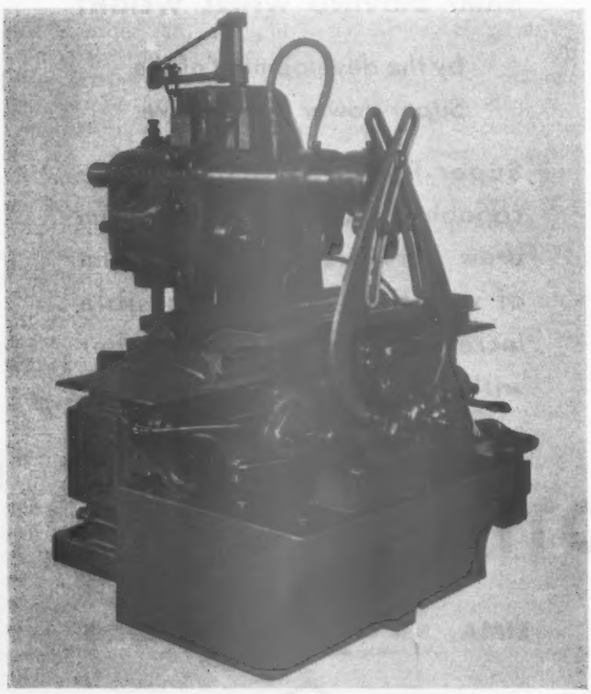
The Standard electrically driven hand grinder and buffer

grinding spindle is 5,400 r.p.m. The grinder is 26 in. long, is 4½ in. in diameter, weighs 20½ lb. and is fitted with SKF ball bearings which run in oil and which are mounted in dust-proof chambers. A trigger switch is employed to control the machine. Current is conveyed to the motor by means of a cable which is constructed by four wires, one of which is used for a ground.

Brown & Sharpe Plain Milling Machine

THE Brown & Sharpe Manufacturing Company, Providence, R. I., has developed a plain milling machine designed especially for short-run production work which has an automatic longitudinal feed of 22 in., a saddle transverse adjustment of 6 in., and a vertical adjustment of the spindle head of 13 in.

The most important feature of the machine, which the builder designates as its No. 22, is the control of all operating functions from the front. Speed changes, feed changes, hand longitudinal adjustment of the table, transverse adjustment of the saddle, vertical adjustment of the spindle head are each accomplished by a single lever. The spindle head is clamped rigidly in position by a single lever which also can be reached from the operating position.



The B. & S. No. 22 plain milling machine

The table is automatically controlled by means of adjustable dogs located at the front of the machine, several cycles of automatic operation being made available with the dogs furnished. Power travel and cutting feed for the table are available in both directions, while hand control by a single directional control lever on the front of the saddle is also provided.

The spindle is mounted on four anti-friction bearings and can be set to rotate either in a right-hand or a left-hand direction. It can also be set to rotate continuously or to stop simultaneously with the engagement of the power travel of the table and to start with the engagement of the cutting feed. When set for automatic operation, the directional control lever on the front of the saddle also controls the functioning of the spindle.

Anti-friction bearings are used throughout the machine and provision is made to adjust them for wear.. Other features include automatic lubrication by filtered oil for all units in the base and driving unit; a pressure greasing system for the end bearings of the table drive shaft; a single oiling station for the saddle and table mechanism; wide chip spaces, and an automatic control for the cutter coolant, which is quickly returned to the coolant tank located in the base of the machine. The speed and feed change system used on the Brown & Sharpe standard milling machines is incorporated in the No. 22 machine, one turn in either direction of a single lever accomplishing a change in speed or feed. Sixteen spindle speeds, ranging in practically a geometric progression from 24 r.p.m. to 620 r.p.m., and sixteen feed changes from 1 in. to 38½ in. per min. are available. Direct reading dials above the levers indicate the speed or feed for which the machine is set.

The machine is of the unit assembly type of construction and is equipped with heat-treated alloy-steel gears and shafts and short rugged splined driving shafts.

The B. & S. No. 22 vertical milling attachment, the vertical milling attachment crane and the fixture flushing pump are furnished as extras when desired. The machine is built with a pad on the back of the column in order that the vertical attachment can be fastened to it when not in use. The crane provides a convenient and quick means for transferring the attachment to the face of the spindle head. The fixture flushing pump is used for flushing chips from the fixtures and the table. Coolant is available at all times when the machine is running, the flow of which is controlled by a spring plunger in the nozzle of the coolant supply pipe.

Cochrane-Bly Abrasive Cut-Off Machine

THE abrasive cut-off machine illustrated has recently been developed by the Cochrane-Bly Company, Rochester, N. Y., to increase the rate of cutting and the number of cuts for a given amount of wheel wear. The machine has a hardened and ground spindle mounted in dust-proof Timken roller bearings, and a heavy carriage mounted on ball-bearing ways which is moved to the work by means of a lever. The carriage is extended at the front underneath the knee and covers the ball-bearing ways, protecting them from grit.

The machine is driven through a four-speed gear box, having hardened nickel-steel gears running in oil and shafts mounted in Timken roller bearings. This gear

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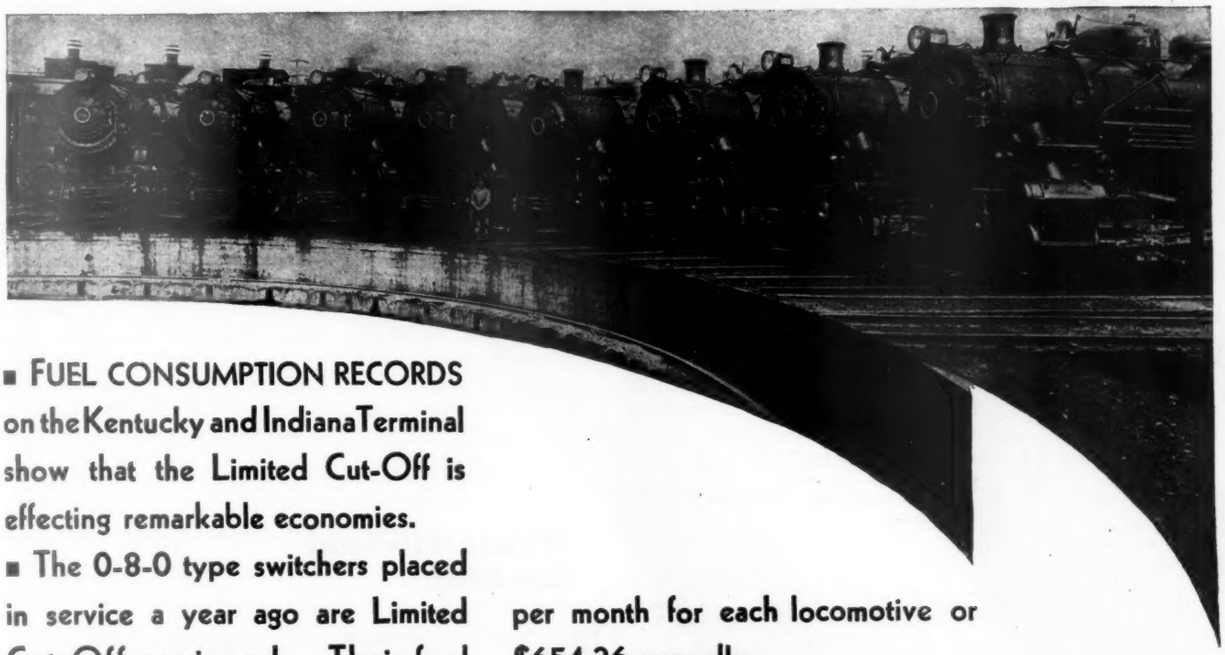
THE LIMITED CUT-OFF

Returns 65.4% on the investment

...on the Kentucky and Indiana Terminal



■ FUEL CONSUMPTION RECORDS on the Kentucky and Indiana Terminal show that the Limited Cut-Off is effecting remarkable economies.

■ The 0-8-0 type switchers placed in service a year ago are Limited Cut-Off equipped. Their fuel requirements, when compared to the 0-8-0 type engines of similar power, but with long cut-off, bought in 1926, reveal a saving of 20.5 tons of coal per month for each of the new switchers.

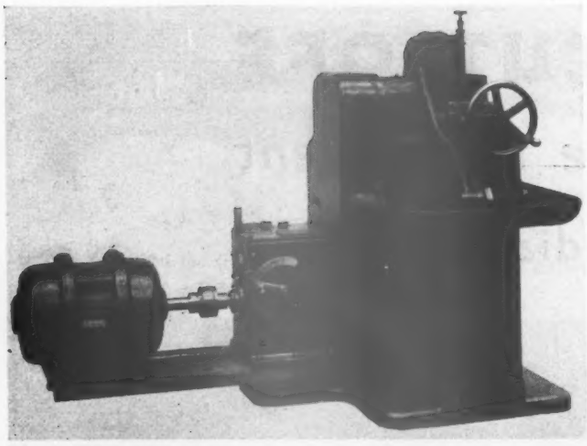
■ In the district where this road operates, fuel cost is approximately $2.66 per ton delivered on the engine. The 20.5 tons of coal saved reduce the coal bill $51.25 per month for each locomotive or $654.36 annually.

■ Such a saving amounts to a 65.4% return on the investment required to incorporate the Limited Cut-Off. In 19 months, each installation will have paid for itself. Then, for the balance of its useful life, each switcher will continue to save this large amount annually.

■ Can you afford to overlook such an opportunity to reduce operating expense?

FRANKLIN RAILWAY SUPPLY CO., INC.

NEW YORK CHICAGO SAN FRANCISCO ST. LOUIS MONTREAL



The Cochrane-Bly cut-off machine for wet and dry cutting

box provides four spindle speeds varying from 2,400 r.p.m. to 3,600 r.p.m., which give a periphery speed to the 16-in. abrasive wheel of 10,000 to 15,000 ft. per min. The machine can be speeded so that the speed changes compensate to a degree for the wear in the wheel diameter and maintain an approximately uniform periphery speed as the wheel wears down.

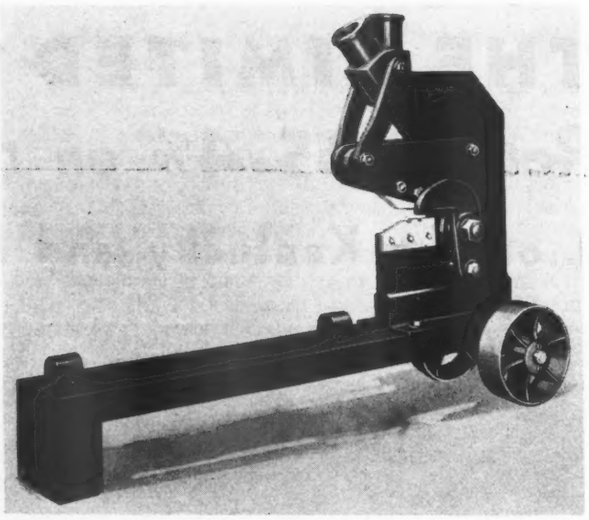
The machine is driven from the speed box to spindle by multiple V-belts. An idler pulley maintains uniform belt tension and compensates for any variation in centers of pulleys caused by carriage movement. It is designed for either wet or dry cutting and is provided with a pump which delivers a stream of coolant or lubricant to the wheel or saw blade. The wear of the wheel when cutting wet is just half the wear when cutting dry for a given number of cuts at the same rate. The machine is designed to cut cold-rolled bar, $1\frac{7}{16}$ in. round, in $2\frac{1}{2}$ sec. and 1-in. rounds or squares in about 1 sec. The machine can also be used with a saw blade for cutting non-ferrous metals, wood, fibre, bakelite, etc.

Specifications of the No. 21 Cochrane-Bly Abrasive Cut-Off Machine

Capacity, round stock	4 in.
Diameter abrasive wheel or saw	16 in.
Speed range of spindle	800-6,000 r.p.m.
Spindle speed for abrasive wheel	2,500-3,600 r.p.m.
Spindle speed for saw blade	800-3,600 r.p.m.
Spindle speed for friction disc	4,200-6,000 r.p.m.
Floor space, belt drive	38 in. by 40 in.
Floor space, motor drive (without speed box)	38 in. by 50 in.
Floor space, motor drive (with speed box)	38 in. by 68 in.
Net weight, belt drive, approx.	1,500 lb.
Motor required	15 hp.

Buffalo No. 104 Armor-Plate Shears

THE Buffalo Forge Company, Buffalo, N. Y., recently added to its line of products the portable hand-operated armor-plate shears shown in the illustration. The armor-plate frame of the shears, from which the tool derives its name, is guaranteed to be unbreakable, while the all-steel truck and pipe handle are both designed for heavy-duty work. The pipe is used both as an operating handle for the shears and as a truck handle. The leverage system, which employs a double socket to permit convenient operation, is powerfully compounded and is designed with no working parts which can get out of order. A stripper on the side of the shears prevents binding.



The Buffalo No. 104 hand-operated shears which are truck mounted

The shears are capable of cutting flat bars 3 in. wide by $\frac{5}{8}$ in. thick and can be fitted with special knives for cutting round stock 1 in. in diameter. The No. 104 shear illustrated is truck mounted and weighs 340 lb. The hand-operated shears can also be furnished in a bench type, which has the same capacities as the No. 104 shears and which weighs 250 lb.

Hyatt Oil-Seal Bushing

THE Hyatt Roller Bearing Company, Harrison, N. J., recently developed an oil-seal bushing for keeping the lubricant within its anti-friction journal box. It is designed to prevent the oil from escaping out of the box along the surface of the axle, which condition exists particularly at high speeds.

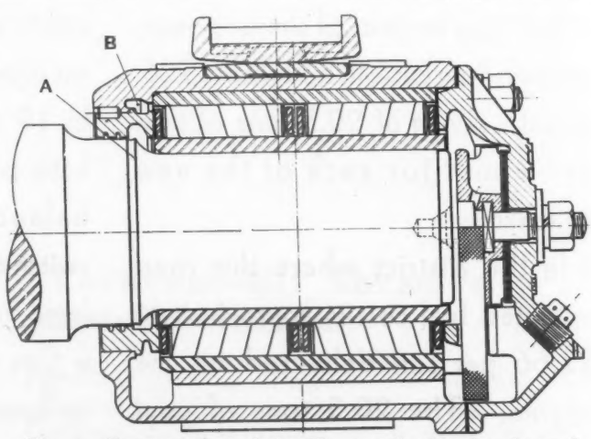


Fig. 1—Cross-section of the Hyatt roller-bearing journal box showing the oil-seal bushing

Reference to Fig. 1 will show that, as the axle rotates within the bearing, oil is thrown off centrifugally from the sharp edge *A* machined on the axle. As the oil pressure builds up within the bearing, the oil can also

(Continued on next left-hand page)

ALWAYS PARALLEL

GOOD PIPE
GOOD SERVICE

Faster freight and passenger schedules, requiring higher operating efficiency, place a heavy responsibility upon the men who specify mechanical equipment. Experience shows that good service and good pipe go hand in hand.

NATIONAL Scale Free Pipe has been developed to eliminate choking of air-actuated equipment and clogging of small orifices in train lines. Clean, smooth pipe means full pressure in the lines and efficient operation of brake equipment.

Likewise, NATIONAL Copper-Steel Pipe—manufactured and used for nearly twenty years—prolongs the useful life of piping on locomotives and cars.

Bulletins Nos. 7 and 11 describe the Scale Free Process and the development of Copper-Steel Pipe. These two features have contributed in making NATIONAL—

America's Standard Wrought Pipe

NATIONAL TUBE COMPANY
Subsidiary of United States Steel Corporation
PITTSBURGH, PA.

U S STEEL

NATIONAL PIPE

escape into the annular chamber *B*. The construction of this chamber is such that the oil drains downward into the sump and does not collect at the lower side of the axle. Likewise, oil drawn off at *A* drains downward into the sump from the horizontal center line and is not

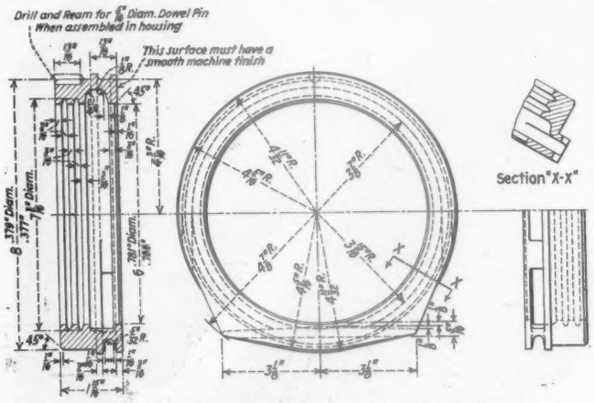
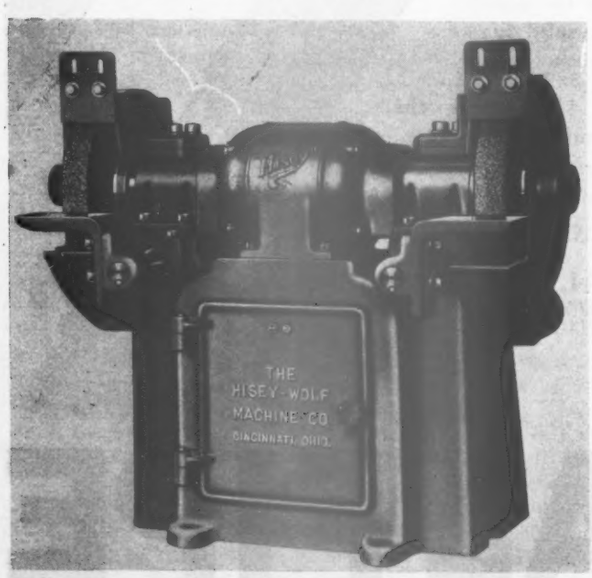


Fig. 2—Details of the Hyatt oil-seal bushing for a 6-in. by 11-in. journal box

permitted to collect below the axle, from where it would leak out. Side ports are provided in the oil-seal bushing to carry the oil back into the sump. The ledge built into the lower portion of the oil-seal bushing, as shown in Fig. 2, assists in deflecting the oil thrown off at *A* back into the sump. This action takes place regardless of the direction of the axle rotation. The ledge is also designed to confine to the sump any surging of the oil caused by the movement of the box.

Hisey Heavy-Duty Floor Grinders

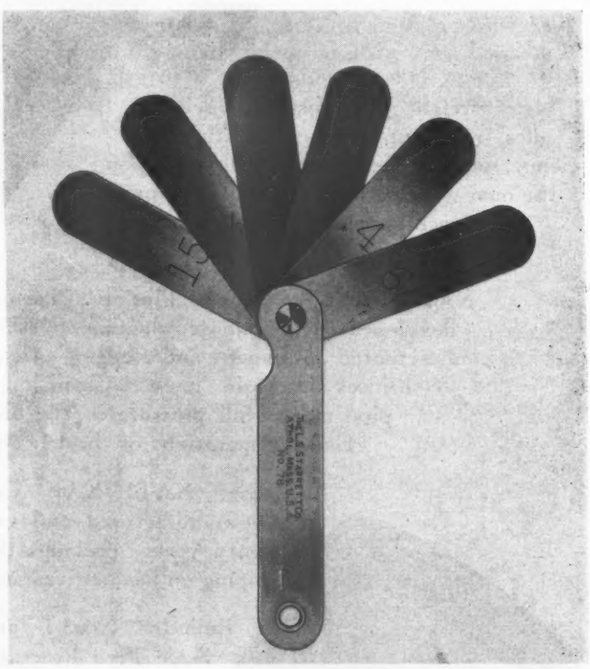
THE Hisey-Wolf Machine Company, Cincinnati, Ohio, recently placed on the market a line of heavy-duty floor grinders with capacities of 5 hp., 7½ hp. and 10 hp. The grinders are similar to other Hisey grinders, but have the following improvements: Adjustable steel-plate guards, heavy steel grinding rests which are adjustable and removable, a large door for access to the motor starter, a larger spindle, and larger bearings. All the feed wires are encased in flexible metal conduit. The 5-hp. capacity machine has 3-in. by 18-in. wheels, a no-load speed of 140 r.p.m., measures 43 in. between centers and 34½ in. from the floor to the spindle and has a net weight of 1,650. The 7½-hp. machine has 4-in. by 20-in. wheels, and a no-load speed of 1,140 r.p.m. It measures 44 in. between wheel centers, 34½ in. from the floor to the spindle and weighs 1,800 lb. The 10-hp. grinder has 4-in. by 24-in. wheels and a no-load speed of 900 r.p.m. It weighs 2,000 lb. and measures 44 in. between wheel centers and 34½ in. from the floor to the spindle.



The Hisey 10-hp. heavy-duty floor grinder

Starrett No. 78 Thickness Gage

IN the illustration is shown a thickness gage, the six leaves of which are .0015 in., .002 in., .003 in., .004 in., .006 in., and .015 in. thick, respectively, giving a range by thousandths from .0015 in. to .031 in. The



The Starrett No. 78 six-leaf thickness gage

gage is the product of the L. S. Starrett Company, Athol, Mass., and is designated as that company's No. 78 gage. The leaves are protected by a steel case, held by a screw-and-stud arrangement which allows them to be replaced when damaged. An eyelet in the end of the case allows the gages to be carried on a ring and, since it is less than 3 in. long, it fits readily in a pocket.

FIFTY YEARS AGO.—The Philadelphia & Reading [now the Reading] has just placed in service a locomotive with a Wooten type firebox which has an inside width of 8 ft. and a grate area of 76 sq. ft. The wheel arrangement is that of the Consolidation type locomotive with the firebox located above and to the rear of the rear pair of driving wheels and the cab above and on each side of the boiler.—*Railroad Gazette*, September 17, 1880.

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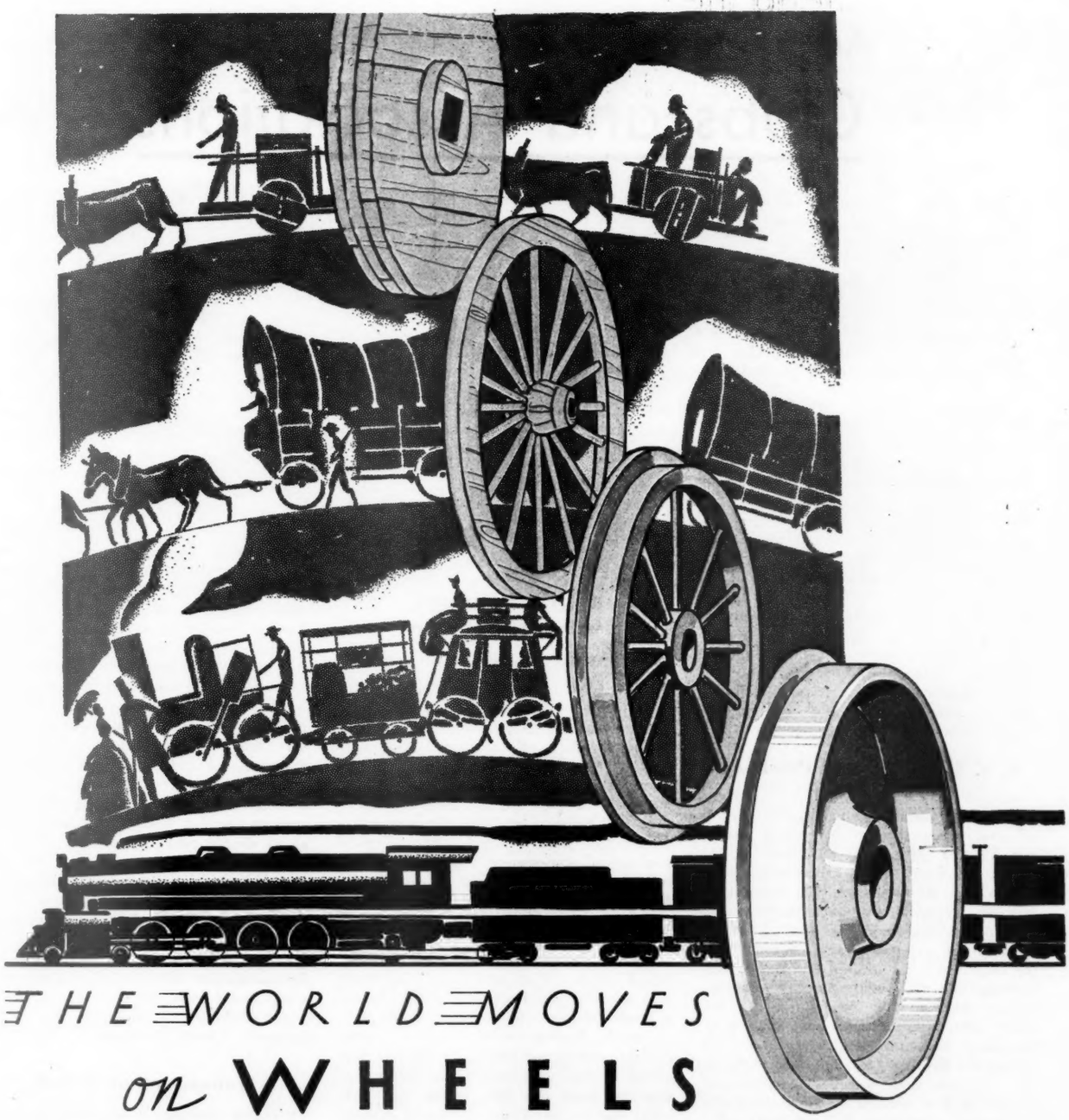


THE WORLD MOVES ON WHEELS

FROM the time man discovered that a rounded object rolls with comparative ease and devised the first crude cart, he has ever been on the move. His means of conveyance have undergone vast changes. The slow joggle of the oxcart has given place to the swift flight of the express train, but never has the wheel been supplanted as the basic factor of transportation. Instead, it has become more vitally important than ever. The speed and weight of modern transportation throw a tremendous responsibility on wheels. Significant then is the fact that Carnegie Wrought Steel Wheels are considered the standard of excellence in today's exacting service. To serve even more efficiently, we are now prepared to furnish Rim-Toughened Wrought Steel Wheels. The process of heat treatment to which these wheels are subjected insures additional service out of all proportion to the small increase in cost. Our wheel engineers will be glad to discuss this matter with you further.

CARNEGIE WROUGHT STEEL WHEELS

Product of Carnegie Steel Company, Pittsburgh, Pa. U.S. STEEL *Subsidiary of United States Steel Corporation* 119

Among the Clubs and Associations

NEW YORK RAILROAD CLUB.—G. E. Doke, president and secretary of the Association of Manufacturers of Chilled Car Wheels, Chicago, will dsicuss chilled iron car wheels at the April 17 meeting of the New York Railroad Club which will be held at 8 p.m. at the Engineering Societies building, 29 West Thirty-Ninth street, New York. Stereopticon slide and motion pictures will also be presented.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Papers on the Practical Application of Alloy Steel to Locomotives and the Theoretical Application of Alloy Steel to Locomotives will be presented by C. E. Barba, mechanical engineer of the Boston & Maine, and A. E. White, professor metallurgical engineering, University of Michigan, respectively, at the session of the Railroad Division of the American Society of Mechanical Engineers to be held during the spring meeting of the society, April 20, at the Tutwiler Hotel, Birmingham, Ala. The other sessions during the spring meeting, April 20-23, will be devoted to discussions of subjects of interest to other divisions of the society.

A. S. T. M. Meets at Pittsburgh

American Society for Testing Materials.—The annual spring group meeting of committees of the American Society for Testing Materials was held at the Hotel William Penn, Pittsburgh, Pa., March 16 to 20, inclusive. The committees met throughout all five days, starting with sessions in the morning and extending through the afternoon and evening with but one break—a dinner on Wednesday evening. In all, twenty-three committees of the society took part but, with the many sub-committee meetings that were necessary, the number of meetings held during the five days totaled approximately 115. About 500 were in attendance. Following is a selected list of the subjects discussed: Committee A-1 on Steel; A-2 on Wrought Iron; A-3 on Cast Iron; Sub-Committee II of A-4 on Heat Treatment of Iron and Steel Castings; A-5 on Corrosion of Iron and Steel; A-7 on Malleable Castings; A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys; Sub-Committee II of B-5 on Cast Metals and Alloys; Sub-Committee of E-1 on Tension Testing; Sub-Committee of E-1 on Effect of Speed of Testing; Sub-Committee of E-1 on Impact Testing; Sub-Committee of E-1 on Elastic Strength of Materials; Technical Committee of E-1 on Presentation of Data; Research Committee on Fatigue of Metals; Sub-Committee I of Sectional Committee on Wrought-Iron and Wrought-Steel Pipe and Tubing; Sectional Committee on Zinc Coating of Iron and Steel; Sectional Committee on Specifications for Fuel Oils (including Diesel fuel), and Sectional Committee on Classification of Coals. ¶In addition, a joint meeting was held of the Committee on Exposure Tests, composed of representatives of Committee A-5 and the American Electroplaters' Society. ¶The group meeting was held in conjunction with the Pittsburgh regional meeting, comprising a symposium on welding, arranged under the joint auspices of the Pittsburgh District Committee and the Pittsburgh Section of the American Welding Society. The symposium consisted of two sessions, the morning session covering a general survey of welding, its history and applications, while the afternoon session discussed the inspection and testing of welding and welded products.

Club Papers

The Future of Electric Traction

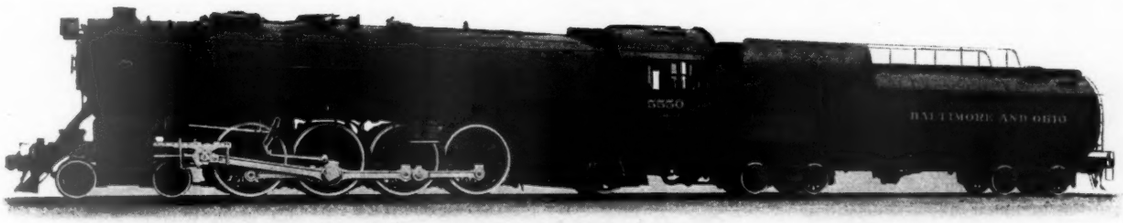
The New York Railroad Club—Meeting held February 20, 1931, at the Engineering Societies Building, 29 West 39 street, New York City. Papers by Sidney Withington, electrical engineer, New York, New Haven & Hartford Railroad and by F. H. Shepard, director of heavy traction, Westinghouse Electric & Manufacturing Co. ¶Thirty-five years' experience with heavy electric traction were reviewed briefly by Mr. Withington. In the course of his address he indicated the need and pointed out the possibility of establishing a unified distribution system for all electrified lines. ¶"A new era," he said, "has been opened by the Pennsylvania in undertaking a project not made necessary by legislative action or by some special problem of grades or tunnels, but which project was undertaken because it was foreseen that the traffic demands upon the Pennsylvania lines will greatly increase in the not distant future and it is believed that electric power is the best tool to use in meeting these demands." ¶In outlining the experience of the New Haven, Mr. Withington cited some of the more important developments which had been made. These included the present form of contact system using a bronze contact wire, large steam-turbine-driven single-phase generators, a selective system of circuit-breaker protection, the gearless single-phase locomotive, and current-collecting devices which will collect current from an overhead contact wire, an overhead third rail or from an under-running third rail located alternately on either side of the track. Pantographs were developed which would successfully collect alternating current from an overhead wire at 80 miles an hour. ¶Mr. Withington said that the most important problem which now required solution is "What electric system is the best for general use for heavy main line electrification in the United States?" In this connection, he said: ¶"It is sincerely to be hoped that this important question will be answered before long. With the growth of railroad electrification, the necessity will arise for the interchance of equipment among railroads, and unless a system of power distribution can be agreed to as standard by the railroads of the country, the diversity of electrical characteristics among railroads is going to be a major calamity, comparable perhaps to the diversity in track gage which caused so much trouble and loss in the early days of railroading." ¶Mr. Withington's paper was supplemented by Mr. Shepard who gave a number of suggestions for future electrification. "Looking to the future," he said, "the ultimate possibilities of railroad electrification are not yet visualized. With the use of alternating-current equipment, the railroads of the future will be able to take advantage of every trend indicated in electrical development today. The reason for this is that with alternating-current motors and equipment there need be no limit as to source and distribution of electric power for railroad use. ¶The two papers were followed by an illustrated discussion of the industrial uses of x-rays by Harold G. Petsing, educational director of the Westinghouse X-Ray Co., and an illustrated discussion and demonstration of the uses and effects of ultra violet rays by Dr. H. C. Rentschler, director of research, The Westinghouse Lamp Company.

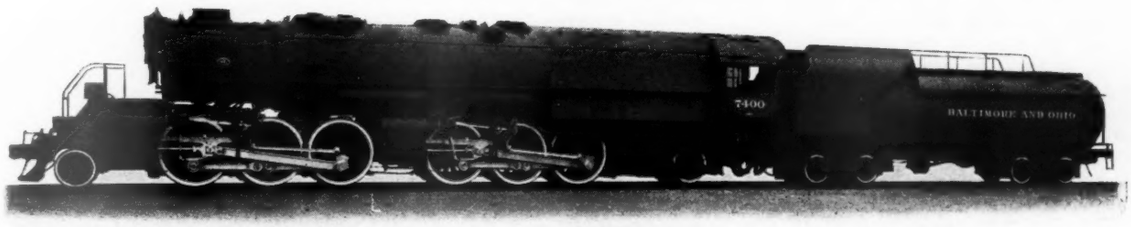
Transportation Trends

Western Railway Club.—Meeting held March 16 at Chicago. Addresses by F. W. Robinson, vice-president, Union Pacific system, on the subject, "The Changing Times;" and by J. E. Buker, vice-president, Vapor Car Heating Company, on the subject, "Transportation." ¶Mr. Buker's paper stressed the decline in railroad traffic, with consequent curtailment of expenses and maintenance work, and urged railroad men as well as supply company representatives to use rail service exclusively when on business and to emphasize the advantages of steam rail service when talking to friends who are prospective travelers or shippers. Mr. Robinson discussed the traffic loss to the railroads, due to the rapid extension of gasoline pipe lines, automobile buses and trucks and intercoastal steamship service

(Continued on next left-hand page)

Locomotives of Unusual Interest





Dimensions and Weights

4-8-2 Type

Cylinders	27½" x 30"
Drivers, diameter	74"
Steam pressure	250 lb.
Grate area	92.3 sq. ft.
Water heating surface	5506 sq. ft.
Superheating surface	2451 sq. ft.
Weight on drivers	260,000 lb.
Weight, total engine	385,000 lb.
Tractive force	65,000 lb.

2-6-6-2 Type

Cylinders (4)	23" x 30"
Drivers, diameter	70"
Steam pressure	250 lb.
Grate area	92 sq. ft.
Water heating surface	6543 sq. ft.
Superheating surface	1666 sq. ft.
Weight on drivers	372,000 lb.
Weight, total engine	465,000 lb.
Tractive force	90,000 lb.

THE BALTIMORE & OHIO has recently placed in service four locomotives of unusual interest, built in our Works. Two are of the Mountain (4-8-2) type for passenger service and two of the single expansion, 2-6-6-2 type for freight. One locomotive of each type has a water tube firebox built according to the design of George H. Emerson, Chief of Motive Power and Equipment.

The passenger locomotives carry an average of 65,000 pounds on each pair of drivers, and are designed to develop maximum capacity without exceeding this limitation.

The freight locomotives are designed to operate on divisions where, heretofore, the heaviest freight engine permitted has been a U. S. R. A. light Mikado developing a tractive force of 54,000 pounds. The new design develops a tractive force of 90,000 pounds, representing an increase of 66 per cent, while the horse power capacity of the boiler is ample for the most severe requirements.

In this our Centennial Year, we are proud to have been entrusted with the task of building these remarkable locomotives.

THE BALDWIN LOCOMOTIVE WORKS ★ 1831 1931

THE BALDWIN LOCOMOTIVE WORKS

PHILADELPHIA

through the Panama canal. Regarding unregulated competition, which constitutes the principal problem now confronting the railways, Mr. Robinson spoke as follows: ¶"The foregoing outline of these competitive features with which western railroads are confronted is indicative of the serious situation and is in a large part, if not almost entirely, the answer as to what is the trouble with their traffic. Railroad men do not complain of fair competition. They do protest against unfair competition. The railroads are subject to the most rigid regulation of any industry. Their competitors are entirely free agents. Until a public sentiment is aroused to the necessity of a correction being applied to these unregulated forms of competition, there will not be much improvement in the revenues of western carriers. ¶"In the meantime, neither traffic nor operating officers of the western carriers are wholly idle. Steps are being taken to meet, so far as we can, some of this competition. We look forward to some constructive action on the part of legislatures now in session, with regard to some form of regulation of automobile, bus and truck competition. It may or may not occur. We do look for and reasonably anticipate a more liberal attitude on the part of the regulatory bodies. Possibly some relief will be granted from the drastic rate reductions which have been ordered. We are seeking and hope to secure some relief from the bad practice of ordering reparations, running back for several years in many cases, and these reparation orders occasionally applying to rates which the commission, itself, has heretofore prescribed as reasonable maximum rates. ¶"This outline is given, not in a pessimistic frame of mind, but rather as a recital of the facts and conditions as they actually prevail. There has ever been a resourcefulness and initiative on the part of railroad traffic officers which may be temporarily stunned by the succession of blows recently received, but certainly it is far from being dead. The American public has an innate sense of fair play and is generally in sympathy with the under dog, a term which may well be applied to the traffic of the western railroads at the present time. Railroad men as a class are good citizens. They are engaged in a constructive industry, one that is an essential and integral part of the industry activity of this nation. They are forward-looking men who deserve and command the respect of the public, and I have sincere confidence that these many problems will be fairly adjusted for all of the interests concerned. This is not going to be accomplished, of course, by merely wishing it on the part of railroad employers, but can be gained only through the intelligent and fair presentation of their problems to the public and to congressional representatives having to do with legislative matters. ¶"There is something for you as an organization to do in this matter. There is something for the business interests of this country to do about it, and there is something for the vast army of stockholders of these many railroads to do about it in their own investment interests."

Directory

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

AIR-BRAKE ASSOCIATION.—T. L. Burton, Room 5605 Grand Central Terminal building, New York.

AMERICAN RAILWAY ASSOCIATION.—DIVISION V.—MECHANICAL.—V. R. Hawthorne, 59 East Van Buren street, Chicago. Meeting June 23, 24 and 25, Congress Hotel, Chicago.

DIVISION V.—EQUIPMENT PAINTING SECTION.—V. R. Hawthorne, Chicago.

DIVISION VI.—PURCHASES AND STORES.—W. J. Farrell, 30 Vesey street, New York. Next meeting May 19, 20, 21, Biltmore hotel, Atlanta, Ga.

DIVISION I. — SAFETY SECTION. — J. C. Caviston, 30 Vesey street, New York.

DIVISION VIII.—CAR SERVICE DIVISION.—C. A. Buch, Seventeenth and H streets, Washington, D. C.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet avenue, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth street, New York.

RAILROAD DIVISION.—Paul D. Mallay, chief engineer, transportation department, Johns-Manville Corporation, 292 Madison avenue, New York. Spring meeting April 20-23, Birmingham, Ala.

MACHINE SHOP PRACTICE DIVISION. — Carlos de Zafra, care of A. S. M. E., 29 West Thirty-ninth street, New York.

MATERIALS HANDLING DIVISION.—M. W. Potts, Alvey-Ferguson Company, 1440 Broadway, New York.

OIL AND GAS POWER DIVISION.—L. H. Morrison, associate editor, Power, 475 Tenth avenue, New York.

FUELS DIVISION.—A. D. Black, associate editor, Power, 475 Tenth avenue, New York.

AMERICAN SOCIETY FOR STEEL TREATING.—W. H. Eiseman, 7016 Euclid avenue, Cleveland, Ohio.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, 1315 Spruce street, Philadelphia, Pa

AMERICAN WELDING SOCIETY.—Miss M. M. Kelly, 29 West Thirty-ninth street, New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andrucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

ASSOCIATION OF RAILWAY SUPPLY MEN.—J. W. Fogg, MacLean-Fogg Lock Nut Company, 2649 N. Kildar avenue, Chicago. Meets with International Railway General Foremen's Association.

BOILER MAKER'S SUPPLY MEN'S ASSOCIATION.—Frank C. Hasse, Oxweld Railroad Service Company, 230 N. Michigan avenue, Chicago. Meets with Master Boiler Makers' Assoc.

CANADIAN RAILWAY CLUB.—C. R. Crook, 2276 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month except in June, July and August, at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT OFFICERS ASSOCIATION.—A. S. Sternberg, master car builder, Belt Railway of Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 2514 West Fifty-Fifth street Chicago. Regular meeting, second Monday in each month, except June, July and August, Great Northern Hotel, Chicago, Ill.

CAR FOREMEN'S CLUB OF LOS ANGELES.—J. W. Krause, 608 South Main street, Los Angeles, Cal. Meetings second Monday of each month except July, August and September, in the Pacific Electric Club building, Los Angeles, Cal.

CAR FOREMAN'S ASSOCIATION OF OMAHA, Council Bluffs and South Omaha Interchange.—Geo. Kriegler, car foreman, Chicago, Burlington & Quincy, Sixteenth avenue and Sixth streets, Council Bluffs, Iowa. Regular meetings, second Thursday of each month at Council Bluffs.

CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.—F. G. Weigman, 720 North Twenty-third street, East St. Louis, Ill. Regular meeting first Tuesday in each month, except July and August. at American Hotel Annex, St. Louis, Mo.

CENTRAL RAILWAY CLUB OF BUFFALO.—T. J. O'Donnell, executive secretary, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meeting, second Thursday each month, except June, July and August, at Hotel Statler, Buffalo.

CINCINNATI RAILWAY CLUB.—D. R. Boyd, 453 East Sixth street, Cincinnati. Regular meeting second Tuesday, February, May, September and November.

CLEVELAND RAILWAY CLUB.—F. L. Frericks, 14416 Adler avenue, Cleveland. Ohio. Meeting second Monday each month, except July, August and September, at the Auditorium, Brotherhood of Railroad Trainmen's building, West Ninth and Superior avenue, Cleveland.

EASTERN CAR FOREMEN'S ASSOCIATION.—E. L. Brown, care of the Baltimore & Ohio, Staten Island, N. Y. Regular meetings fourth Friday of each month, except June, July, August and September.

INDIANAPOLIS CAR INSPECTION ASSOCIATION.—E. A. Jackson, Box 22, Mail Room, Union Station, Indianapolis, Ind. Regular meetings first Monday of each month at Hotel Severin, Indianapolis, at 7 p.m. Noon-day luncheon 12:15 p.m. for Executive Committee and men interested car department.

INTERNATIONAL RAILROAD MASTER BLACKSMITH'S ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

INTERNATIONAL RAILROAD MASTER BLACKSMITH'S SUPPLY MEN'S ASSOCIATION.—J. H. Jones, Crucible Steel Company, of America, 650 Washington boulevard, Chicago.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—C. T. Winkless, Room 707, LaSalle Street Station, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabash street, Winona, Minn.

INTERNATIONAL RAILWAY SUPPLY MEN'S ASSOCIATION.—W. J. Dickinson, acting secretary, 1703 Fisher building, Chicago. Meets with International Railway Fuel Association.

LOUISIANA CAR DEPARTMENT ASSOCIATION.—L. Brownlee, 3730 South Prieur street, New Orleans, La. Meetings third Thursday.

MASTER BOILERMAKER'S ASSOCIATION. — A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

MASTER CAR BUILDERS' AND SUPERVISORS' ASSOCIATION.—See Car Department Officers Association.

NATIONAL SAFETY COUNCIL—STEAM RAILROAD SECTION: W. A. Booth, Canadian National, Montreal, Que. William Penn and Fort Pitt Hotels, Pittsburgh, Pa.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meeting, second Tuesday in each month, excepting June, July, August and September. Copley-Plaza Hotel, Boston.

NEW YORK RAILROAD CLUB.—Douglas I. McKay, executive secretary, 26 Cortlandt street, New York. Meetings third Friday in each month, except June, July and August, at 29 West Thirty-ninth street, New York.

PACIFIC RAILWAY CLUB.—W. S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately.

PUEBLO CAR MEN'S ASSOCIATION.—I. F. Wharton, chief clerk, Interchange Bureau, Pueblo, Colo.

RAILWAY BUSINESS ASSOCIATION. — Frank W. Noxon, 1124 Woodward building, Washington, D. C.

RAILWAY CAR MEN'S CLUB OF PEORIA AND PEKIN.—C. L. Roberts, chief clerk, Peoria & Pekin Union Railway, 217 Lydia avenue, Peoria, Ill.

RAILWAY CLUB OF GREENVILLE.—Paul A. Minnis, Bessemer & Lake Erie, Greenville, Pa. Meetings third Tuesday of each month, except June, July and August.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1841 Oliver building, Pittsburgh, Pa. Regular Meeting fourth Thursday in month, except June, July and August. Ft. Pitt Hotel, Pittsburgh, Pa.

RAILWAY EQUIPMENT MANUFACTURERS' ASSOCIATION.—F. W. Venton, Crane Company, 836 South Michigan avenue, Chicago. Meets with Traveling Engineers' Association.

RAILWAY FIRE PROTECTION ASSOCIATION.—R. R. Hackett, Baltimore & Ohio, Baltimore, Md.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.—J. D. Conway, 1841 Oliver building, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, American Railway Association.

ST. LOUIS RAILWAY CLUB.—B. W. Frauenthal, M. P. O. Drawer 24, St. Louis, Mo. Regular meetings, second Friday in each month, except June, July and August.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings third Thursday in January, March, May, June, September and November. Annual meeting third Thursday in November, Ansley Hotel, Atlanta, Ga.

SUPPLY MEN'S ASSOCIATION. — E. H. Hancock, treasurer, Louisville Varnish Company, Louisville, Ky. Meets with Equipment Painting Section, Mechanical Division, American Railway Association.

SUPPLY MEN'S ASSOCIATION.—Bradley S. Johnson, W. H. Miner, Inc., Chicago. Meets with Car Department Officers Association.

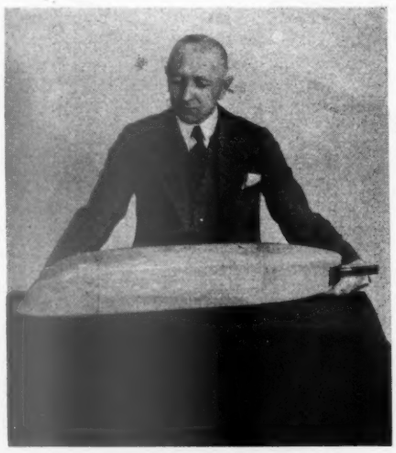
TRAVELING ENGINEERS' ASSOCIATION. — W. O. Thompson, 1177 East Ninety-eighth street, Cleveland, Ohio.

WESTERN RAILWAY CLUB.—W. J. Dickinson, 343 South Dearborn street, Chicago. Regular meetings, third Monday in each month.

NEWS

Westinghouse Tests Stream-Lined Car Models

In a series of tests with scale models of present type and stream-lined cars in winds of varying velocities up to 80 m.p.h., Dr. Oscar G. Tietjens of the Research



Dr. Oscar G. Tietjens with stream-line model of a railway motor car

Laboratory, Westinghouse Electric & Manufacturing Company, has developed a number of conclusions which are believed to be correct within a close percentage when applied to full size equipment.

In the case of a heavy locomotive and two heavy coaches, stream-line design saves 13 per cent of the required total horsepower for a speed of 35 m.p.h. and 32 per cent of the total horsepower required for a speed of 75 m.p.h., in present equipment of similar weight.

It requires 286 hp. to drive the present type of light interurban electric car at 80 m.p.h. Tests, made in the Westinghouse wind tunnel, indicated that the same type of car of stream-line design can be driven 80 m.p.h. with only 140 hp., thus saving 146 hp. At 35 m.p.h., stream-lining will save 30 per cent of the horsepower required for a similar car of the present shape and at a speed of 75 to 80 m.p.h., such a car will travel with one-half the horsepower required to send the present car at that speed.

According to Dr. Tietjens' tests, stream-lining is not so important for the slower speeds or for heavy equipment, although it is of benefit at high speeds and particularly for light equipment. As the weight can be decreased, journal friction is reduced, which explains the advantage that goes to lighter rolling stock. From these results, Dr. Tietjens concludes that stream-lining will be worth while for medium and high-speed light interurban cars and for heavy high-speed trains.

Dr. Tietjens states that for an ordinary locomotive the potential benefit is sixteen times greater than the same coefficient for a stream-lined zeppelin of the same cross-sectional area.

From this entire program of activity, it is expected to work out new styles in high-speed cars and trains that will be revolutionary in character and appearance as well as notable for their efficiency and economy of operation. It is believed that Dr. Tietjens' tests in the Westinghouse Research Laboratories open up a new field of possibilities in operating trains and cars faster than at present without increased energy or fuel requirements.

Fuel Performance on the Frisco

The St. Louis-San Francisco reduced its fuel consumption for freight service during January to 167 lb. per 1,000 gross ton-miles, as compared with 210 lb. per 1,000 gross ton-miles in January, 1930. In passenger service, the fuel consumed in January was 15.6 lb. per passenger car-mile, a reduction of 16 per cent, as compared with the same month last year. In switching service the pounds of fuel per switching locomotive-mile decreased 7.74 per cent. The saving in fuel for January, 1931, as contrasted with the same month in 1930, is equivalent to approximately 25,000 tons of coal or 500 carloads. During the first month of 1931, the average freight-train load was 1,403 tons, while in January, 1930, it was 1,281.

This performance is a continuation of the results secured for the 12 months of 1930 when the fuel consumed in freight service, 163 lb. per 1,000 gross ton-miles, established a new record for the system. The figure for 1930 likewise represented an improvement over 1929 when the amount was 170 lb. per 1,000 gross ton-miles. In 1920, the total was 255 lb. per 1,000 gross ton-miles. The pounds of fuel per passenger car-mile in 1930 totaled 15.2 which was equal to the 1929 performance. In switching service the fuel per locomotive-mile average 144 lb., equalling the performance for 1929.

Enginemen Ask I.C.C. To Require Mechanical Stokers

Hearings on the complaint filed by the Brotherhood of Locomotive Firemen and Enginemen and the Brotherhood of Locomotive Engineers asking the Interstate Commerce Commission to require that steam locomotives generally be equipped with mechanical stokers were begun at Washington on March 24 before Special Examiner J. L. Rogers. A large number of enginemen from various roads, including many demoted engineers, were on hand to testify and it is expected that the hearing will last for several weeks. Although the complaint was based on the ground that the stokers are required for safety, some of the first witnesses who testified mentioned particularly that with stoker-fired locomotives they would be "in shape" to enjoy social affairs in the evening. They had emphasized the arduous work of hand-firing and averred that on a heavy run their duties with the scoop often interfered with the observance of signals and other duties. Some witnesses expressed the opinion that a ton of coal an hour was a reasonable amount for a man to handle, although they spoke of shoveling anywhere from 10 to 26 tons of coal on a run. One witness told of handling 20 to 26 tons of coal on a 140-mile freight run that often ran up to the 16-hour

(Continued on second left-hand page)

Wind tunnel in the research laboratories of the Westinghouse Electric & Manufacturing Company

To Haul Full Tonnage Freight

THE Lehigh Valley Railroad needed a locomotive that could haul full tonnage freight trains at passenger train speeds and extra heavy passenger trains on regular schedule, as part of its plan to expedite service over its entire line and at the same time reduce operating expenses.

The American Locomotive Company, to meet these exacting requirements, has completed at its Schenectady Shops a new locomotive that is veritably a meteor of steam and steel.

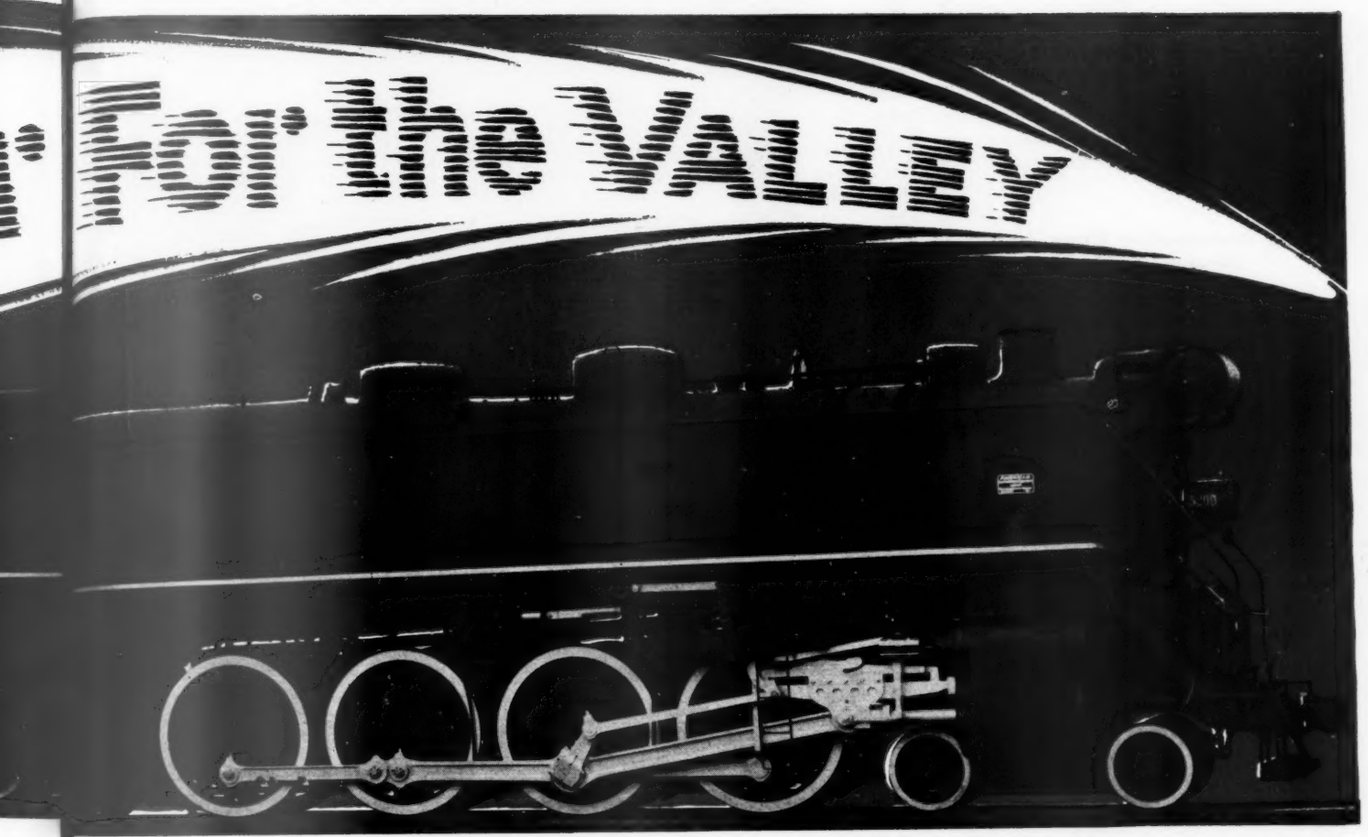
This locomotive represents many changes from previous Lehigh Valley construction. The most modern safety, power producing, fuel and labor saving devices are employed and when the locomotive is placed in service many new performance records and new economies are confidently expected.

This new meteor of the Valley is a 4-8-4 type locomotive having a four-wheel engine truck, four pairs of drivers and a four-wheel trailing truck.

With the 26 x 32 inch cylinders, a steam pressure of 255 lb. and driving wheels 70 inches in diameter, the locomotive develops with its booster a starting effort of 85060 lb.

AMERICAN LOCO

30 CHURCH STREET



Trains at Passenger Train Speeds

IT is approximately 108 feet in length over all and with tender weighs 780,800 lb. The large tender capacity of 18,000 gallons of water and 28 tons of coal makes possible the contemplated long runs without stops.

The graceful "stream" lines of this locomotive are an outstanding feature which have caused considerable favorable comment. For quite some time Alco Engineers have made a determined effort to remove all piping from the sides of the boiler in order to create a clean, clear cut flowing effect which now has become a distinguishing identification for an Alco engine.

This new triumph of dynamic symmetry combines immense power, high speed, sustained capacity, remarkable economy of operation and grace of lines.

It is a striking example of the extraordinary benefits that can be obtained through the hearty cooperation of the railroad's Mechanical Officials and Alco Engineers all working for a common purpose—greater haulage at lower costs—greater efficiency—better service for the traveling public and shippers. It is such cooperation that will keep the steam locomotive as the main prime mover and the railways as the outstanding method of transportation.

MOTIVE COMPANY

NEW YORK CITY

limit but said that now on the same run, with a stoker-fired locomotive, the tonnage is increased and the run is generally completed before overtime begins. He said that after 16 hours of hand-firing he often felt "played-out, cooked out and burned out and lucky to get home without help," but that now, after eleven hours on a stoker engine, if the family wishes to go out in the evening he is in shape to go with them.

Long Locomotive Runs on the Boston & Maine

THE BOSTON & MAINE and the New York, New Haven & Hartford are now running locomotives through between New Haven, Conn., and Portland, Me., 271 miles; one passenger train and one freight train each way daily. The route is by way of New London, Putnam, Worcester, Ayer and Lowell. Preparations are being made for a similar arrangement between New Haven, Conn., and White River Junction, Vt., several trains each day; and also for freight trains between New Haven and Boston by way of Worcester and Ayer.

Wage Statistics Compiled for 1930

THE AVERAGE NUMBER of railway employees in the service of Class I railroads for the year 1930 was 1,510,688, as compared with 1,686,769 in 1929 and 1,680,187 in 1928, according to a consolidation issued by the Interstate Commerce Commission of the monthly summaries of wage statistics issued during the year. For the year, the average, based on the twelve monthly counts as of the middle of each month, was a decrease of 10.44 per cent as compared with 1929. The total compensation for the year was $2,590,274,843, a decrease of 11.92 per cent. The average straight-time hourly earnings for all employees reported on the hourly basis increased from 62.5 to 63.5 cents, and the average straight-time daily earnings of all employees reported on the daily basis increased from $8.42 to $8.55. The number of employees in January, 1930, was 1,561,035 and in December of last year it was 1,356,558.

Supply Trade Notes

R. C. VILAS, chairman of the board of the Pyle-National Company, Chicago, has resigned on account of poor health.

THE HUTCHINS CAR ROOFING COMPANY has moved its New York office from 342 Madison avenue, to 500 Fifth avenue.

CLARK P. POND has been appointed vice-president engineering and sales, of the Truscon Steel Company, Youngstown, Ohio.

JOHN D. TYSON, formerly assistant metallurgical engineer of the Standard Steel Works Company, Burnham, Pa., has been appointed chief metallurgist.

BRADLEY STOUGHTON, since 1923 professor of metallurgy at Lehigh University, has been appointed consulting metallurgist of Standard Steel Works Company, Burnham, Pa.

GEORGE A. LONG, manager of the Industrial Brownhoist Corporation, Cleveland, Ohio, has been transferred to Bay City, Mich., to succeed J. Stanley See resigned.

J. H. BAILY, secretary of the Edgewater Steel Company, Pittsburgh, Pa., has been elected a vice-president and D. W. McGeorge, assistant secretary, has been elected secretary.

THE GEOMETRIC TOOL COMPANY, New Haven, Conn., has appointed J. C. Ross & Co., 2207 First avenue, South, Seattle, Wash., as its selling agents in the States of Washington and Oregon.

THE STANDARD COUPLER COMPANY, New York, has moved its Chicago office from 120 South La Salle street, to the Strous building, 310 South Michigan avenue. B. W. Brooks is resident representative of the company at Chicago.

THE ARMCO RAILROAD SALES COMPANY, which handles the sales of wrought steel wheels, locomotive packet sheets, car-siding sheets and plates, and galvanized black and blue annealed sheets to the railroads for the American Rolling Mill Company, Middletown, Ohio, has opened a district sales office at 1120 Midland Bank building, Cleveland, Ohio. W. N. Crout is the district sales representative.

HENRY B. NICKERSON, vice-president of the Consolidated Ashcroft Hancock Company, has been elected vice-president in charge of sales of the Ashton

Henry B. Nickerson

Valve Company, Boston, Mass. Mr. Nickerson will have his headquarters at the main office. Previous to his service with the Consolidated Ashcroft Hancock Company, Mr. Nickerson had served with the American Schaeffer & Budenberg Corporation and the American Steam Gage & Valve Manufacturing Company.

THE HYATT ROLLER BEARING COMPANY, Harrison, N. J., has moved the office of its western sales division from 111 West Washington street to the Carbide & Carbon building, 230 North Michigan avenue, Chicago.

J. S. LEMLEY and Frank J. Kearney, vice-presidents of the T-Z Railway Equipment Company, Chicago, have been elected vice-presidents of the Morris B. Brewster Company, Chicago. William Wright, mechanical engineer of the T-Z Railway Equipment Company, has been appointed mechanical engineer of the Morris B. Brewster Company.

E. M. VEHMEYER, sales manager in the Detroit, Mich., plant of Joseph T. Ryerson & Son, Inc., has been appointed manager of the plant. Mr. Vehmeyer has been associated with Joseph T. Ryerson & Son, Inc., for over 22 years, most of his time having been spent in the sales and service departments. For the last two years he has held the position of sales manager in the Detroit plant. W. H. Basse, formerly Detroit plant manager, has been transferred to Chicago where he will engage in special sales work.

(Continued on next left-hand page)

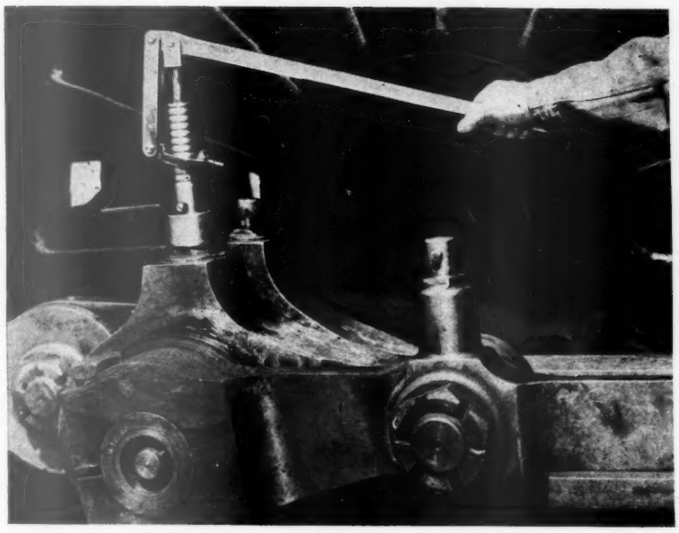
Domestic Orders Reported During March, 1931

Locomotives

Name of Company	Number ordered	Type	Builder
Chicago, Milwaukee, St. Paul & Pacific	8	4-6-4	Baldwin Loco. Works
Total for month	8		

Freight Cars

Name of Company	Number ordered	Type	Builder
Bessemer & Lake Erie	350	Hopper	American Car & Fdy. Co.
	300	Hopper	Pressed Steel Car Co.
	300	Hopper	Standard Steel Car Corp.
	100	Hopper	Greenville Steel Car Co.
Union Pacific	1	Plow	Rodger Ballast Car Co.
Fisher Lumber Corp.	20	Logging	American Car & Fdy. Co.
Union Railroad	10	Air dump	Differential Steel Car Co.
	10	Air dump	Magor Car Corp.
East Jersey Railroad & Terminal	17	Tank	American Car & Fdy. Co.
The Hauser Construction Company	8	Air dump	Magor Car Corporation
Merchants Despatch, Inc.	1000	Refrigerator	Merchants Despatch Trans. Co.
L.C.L. Corporation	50	Container	American Car & Fdy. Co.
Total for month	2166		



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The more engines you equip the lower your lubrication costs—the less trouble you will have with hot bearings, the fewer your failures and delays and the greater your savings.

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RELIANCE MACHINE & STAMPING WORKS, Inc.
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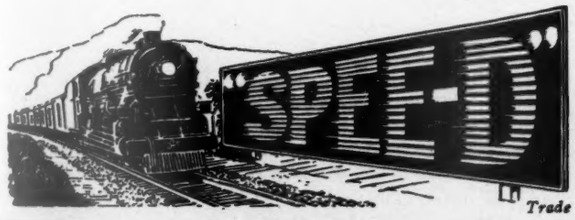
Mumford Medland, Ltd., Winnipeg
International Railway Supply Company, 30 Church St., New York City
A. L. Dixon, 325 W. Ohio Street, Chicago, Ill.



Saves Time, Labor, Grease and Grease Plugs

Trade Mark Registered

THE BETHLEHEM STEEL COMPANY, Bethlehem, Pa., has become a licensee of the Nitralloy Corporation, New York, in the field of alloy steels. In the United States there are five other licenses for Nitralloy steel and, in addition, licenses have been granted to six companies manufacturing steel castings.

Obituary

ALBERT M. HICKS, who was connected with the Hicks Locomotive & Car Company, Chicago, until his retirement in 1909, died in Taylorville, Ill., on February 5 from pneumonia.

STANLEY HALE BULLARD, vice-president of the Bullard Company, Bridgeport, Conn., died on March 22 at his home in Fairfield, Conn., at the age of 53. Mr. Bullard, who had suffered with heart trouble for about a year and was obliged to give up his business and other activities, had apparently recovered, and for the past several weeks had been assuming more actively his former place in the Bullard organization. Mr. Bullard was the son of Edward Payson Bullard, the founder of the Bullard Company, and

Stanley Hale Bullard

was born on July 4, 1877, at Hoboken, N. J. He had been prominent in the machine tool industry as a manufacturer for the past 35 years, together with his four brothers, who, comprising the executive staff of the Bullard Company, followed the business established by their father 51 years ago. After graduating in 1890 from the New York Military Academy, he entered the employ of his father as a machinist apprentice and, after completing this period of service, was engaged in sales work. He first became manager of the New York office of the company and later manager of the eastern sales district. In 1905 he was appointed general sales manager and in 1915 elected a vice-president, becoming also general works manager. Mr. Bullard was an enthusiastic and outstanding factor in the progress of the metal working industry and, besides his many local civic activities, gave a great deal of his time to civic affairs of national importance to business in general. At various times he held offices with many technical and other organizations.

Personal Mention

General

G. R. GALLOWAY, master mechanic of the Baltimore & Ohio at Baltimore, Md., has been appointed acting superintendent motive power, Western lines, with headquarters at Cincinnati, Ohio.

A. K. GALLAWAY, superintendent of motive power of the Western lines of the Baltimore & Ohio, has been appointed acting superintendent motive power, Eastern lines, succeeding C. A. Gill who has been granted a leave of absence to assist in the reorganization of Russian railroads.

JAMES E. DAVENPORT, assistant to assistant general manager of the New York terminal district of the New York Central, has been appointed assistant to vice-president. Mr. Davenport was born at Charlestown, W. Va., on October 8, 1887, and was educated at Georgia School of Technology, receiving the degrees of B. S. in M. E. in 1908, and B. S. in E. E. in 1909. He entered railroad service in 1909 as special apprentice at the West Albany shops of the New York Central, remaining in that position until 1912,

James E. Davenport

when he was appointed enginehouse foreman at N. White Plains, N. Y. In 1914 Mr. Davenport was appointed dynamometer car engineer; in 1917 trainmaster of the Harlem division, and in 1918 was transferred to a similar position on the Mohawk division. He served as engineer dynamometer tests from 1920 to 1923, and in the latter year was appointed superintendent fuel in locomotive performance. In 1926 he was advanced to the position of superintendent of the Adirondack division; from 1927 to 1930 served as superintendent of the River division, and in 1930 was appointed assistant to assistant general manager.

Master Mechanics and Road Foremen

W. B. PORTERFIELD, superintendent of the Glenwood shops of the Baltimore & Ohio at Pittsburgh, Pa., has been appointed acting district master mechanic of the West Virginia district, with headquarters at Wheeling, W. Va.

THE TITLE of R. Skidmore, shop superintendent of the Kansas City Southern at Pittsburg, Kan., has been changed to master mechanic.

F. M. SCHLICER, assistant master mechanic of the Decatur shops of the Louisville & Nashville at Albany, Ala., has retired under the pension rules of the company.

J. M. PIERCE, master mechanic of the Kansas City Southern at Pittsburg, Kan., has been appointed to fill the newly created position of general master mechanic at Pittsburg. Mr. Pierce, who will have jurisdiction over locomotive repairs on the entire line, was born in Paris, Tenn., on February 7, 1885. He entered the employ of the Kansas City Southern on November 16, 1908, as a machinist at Shreveport, La. On August 1, 1914, he was promoted to

J. M. Pierce

the position of enginehouse foreman; on July 4, 1918, became general foreman at Shreveport, and on October 25, 1922, appointed master mechanic at Heavener, Okla. He returned to Shreveport as master mechanic on November 1, 1923, and was transferred to Pittsburg on May 1, 1929.

THE HEADQUARTERS of D. E. McLean, master mechanic of the Dauphin division of the Canadian National, have been removed from Kamsack, Sask., to Dauphin, Man.

A. E. MCMILLAN, master mechanic of the Baltimore & Ohio at Wheeling, W. Va., has been appointed acting district master mechanic of the Maryland district, with headquarters at Baltimore, Md.

T. D. SAAR, chief locomotive inspector of the Kansas City Southern, has been promoted to the position of division master mechanic, with headquarters at Pittsburg, Kan. Mr. Saar was born at

(Continued on next left-hand page)